# Montana Department of Environmental Quality

## Sampling and Analysis Plan
## Berg Lumber Mill Site
## (also known as the Lewistown Groundwater Investigation)
## Lewistown, Montana

February 8, 2007

*Final*

# Contents

## Appendices

# List of Acronyms

| | |
|---|---|
| ARARs | applicable or relevant and appropriate requirements |
| bgs | below ground surface |
| BLMS | Berg Lumber Mill site |
| CECRA | Comprehensive Environmental Cleanup Responsibility Act |
| COCs | contaminants of concern |
| DETs | Decision Error Tables |
| DEQ | Montana Department of Environmental Quality |
| DHES | Montana Department of Health and Environmental Sciences |
| DQO | Data Quality Objectives |
| EA | Environmental Assessment |
| ENF | Enforcement Division |
| EPA | United States Environmental Protection Agency |
| EPH | Extractable Petroleum Hydrocarbons |
| FWP | Montana Department of Fish, Wildlife, and Parks |
| HASP | health and safety plan |
| IDW | investigation-derived wastes |
| LCS | laboratory control samples |
| MBMG | Montana Bureau of Mines and Geology |
| MS/MSD | matrix spike/matrix spike duplicates |
| NCP | National Contingency Plan |
| OERR | Office of Emergency and Remedial Response |
| PAHs | polynuclear aromatic hydrocarbons |
| PC | percent complete |
| PCBs | polychlorinated biphenyls |
| PCP | pentachlorophenol |
| PID | photoionization detector |
| ppb | parts per billion |
| PRGs | Preliminary Remediation Goals |
| QA/QC | Quality Assurance/Quality Control |
| RBSLs | Risk-Based Screening Levels |
| RPD | relative percent difference |
| SAP | Sampling and Analysis Plan |
| SI | Site Investigation |
| SSLs | Soil Screening Levels |
| SVOCs | Semivolatile organic compounds |
| TEH | Total Extractable Hydrocarbon |
| TMDL | Total Maximum Daily Load |
| VOCs | volatile organic compounds |
| VPH | volatile petroleum hydrocarbons |

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# Section 1
# Introduction/ Background

Various lumber-mill related activities occurred between 1970-1994 at the Berg Lumber Mill site (BLMS) in Lewistown, Montana. This site is also known as the Lewistown Groundwater Investigation and is filed under this name in the Montana Department of Environmental Quality's (DEQ's) Groundwater Remediation Program files. Soil sampling conducted previously at this site has shown that the past activities have caused soils to be contaminated with pentachlorophenol (PCP), dioxin/furan and petroleum. To assist with decisions regarding the cleanup of the site, additional soil sampling will be conducted to better define the extent and magnitude of the contaminated soils. Also, slug testing will be conducted to aid with the development of site-specific cleanup levels, and a monitoring well will be installed to assess background levels of manganese in groundwater. Neither groundwater nor surface water sampling is required by this Sampling and Analysis Plan (SAP). The contents of this SAP outline the activities that will be conducted at BLMS to gather the data needed.

Please note that this SAP sets forth two sets or "tiers" of soil sampling. The first tier of soil samples is critical for determining the extent and magnitude of PCP and dioxin/furan contamination. The first tier of samples will also provide data that will allow a site-specific cleanup level to be generated for PCP. In Figure 3, the first tier soil samples are indicated in red. The second tier of samples (shown as grey triangles in Figure 3) is more focused on petroleum hydrocarbons and confirmation sampling.

At the time of the drafting of this SAP, due to budgetary constraints, DEQ will be able to collect and analyze only the first tier samples (or a subset of the first tier samples). However, the second tier samples are provided in this SAP in the event that additional resources become available to complete this work.

## 1.1 Site History and Current Status

The BLMS property was previously used for the following operations: lumber mill and associated activities, post and pole treating, and storage area for miscellaneous equipment, machine parts, vehicles, lumber, and sawdust piles. Most of the site's buildings, machinery, and other equipment and scrap metal have been removed, although the concrete foundations for the buildings remain as well as some piles of wood, debris, barrels, tires, etc. This property is part of a Chapter 7 bankruptcy and is currently controlled by a court appointed Bankruptcy Trustee for the George Berg Estate (Trustee).

The large onsite sawdust pile, which covered approximately 2 acres, was sloughing into Big Spring Creek and causing concerns about water quality. Also, the pile would frequently catch fire, either due to smoldering from an intentionally set and permitted fire, or from heat buildup from natural composting processes in the pile. The DEQ's Solid Waste Program is monitoring the removal and disposal or recycling of the sawdust pile.

In April 2001, a former employee of the BLMS complained to DEQ's Enforcement Division (ENF) about improper disposal of petroleum hydrocarbons, pentachlorophenol, and transformer fluids at the site, in addition to the openly burning sawdust pile. ENF investigated the complaint by inspecting the site and collecting one soil sample from a stained area near the on-site gravel pit (see Figure 2). Based on the results of this investigation, ENF required a Phase I Environmental Assessment (EA) of the property. Pioneer Technical Services, Inc. (Pioneer) conducted the work, which is described in Pioneer's October 16, 2001 *Phase I Environmental Assessment for the Berg Lumber Company, Joyland Road, Lewistown, Montana*. Surface soil samples (0-2 feet deep) indicated the presence of petroleum contamination exceeding DEQ's Risk-Based Screening Levels (RBSLs) and PCP contamination exceeding the United States Environmental Protection Agency (EPA) Region 9 Preliminary Remediation Goals (PRGs) and Soil Screening Levels (SSLs). Polychlorinated dioxins and furans are by-products of the manufacturing of PCP. BLMS had a mechanical shop on site, and various solvents and/or gasoline were frequently used in such shops to clean tools and parts. Thus, the contaminants of concern (COCs) at this site include petroleum hydrocarbons, volatile petroleum hydrocarbons (VPH), solvents, PCP, and dioxins and furans.

During the period of August 16 through August 19, 2004, sampling of surface water, sediment, groundwater and soil was conducted under the *Berg Lumber Phase II Site Investigation Sampling and Analysis Plan* (SAP), (DEQ, 2004). A summary of these data is included in *Report of Findings for the Berg Lumber Mill Site*, (Environmental Consulting, 2005). From this sampling event, surface soil samples and subsurface soil samples indicated contamination of PCP, dioxins/furans and petroleum constituents above the PRGs and SSLs.

## 1.2 Location

The BLMS site is located approximately 2 miles northwest of downtown Lewistown, Montana, and is approximately 31 acres in size. The site is bordered on the west by Joyland Road, on the south by East Cheadle Street, and on the northeast by Big Spring Creek. It is located in the East ½ of the Southeast ¼ of Section 9, of Township 15 North and Range 18 East. A residential area borders the site to the south, and a fishing access area owned by the Montana Department of Fish, Wildlife, and Parks (FWP) borders the site to the Northeast. See Figures 1 and 2 for additional information.

## 1.3 Hydrology and Hydrogeology

Big Spring Creek runs along the Northeast border of the site (Figures 1 and 2). Historical U.S. Geological Survey data (1932-1958) from the former gauging station on Big Spring Creek in Lewistown indicate a base flow in the creek of approximately 110 cubic feet per second (cfs). Recorded peak flows for the period exceeded 220 cfs. At the site, surface water flows to the northwest.


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**FIGURE 1**
**SITE LOCATION MAP**
**BERG LUMBER MILL SITE**

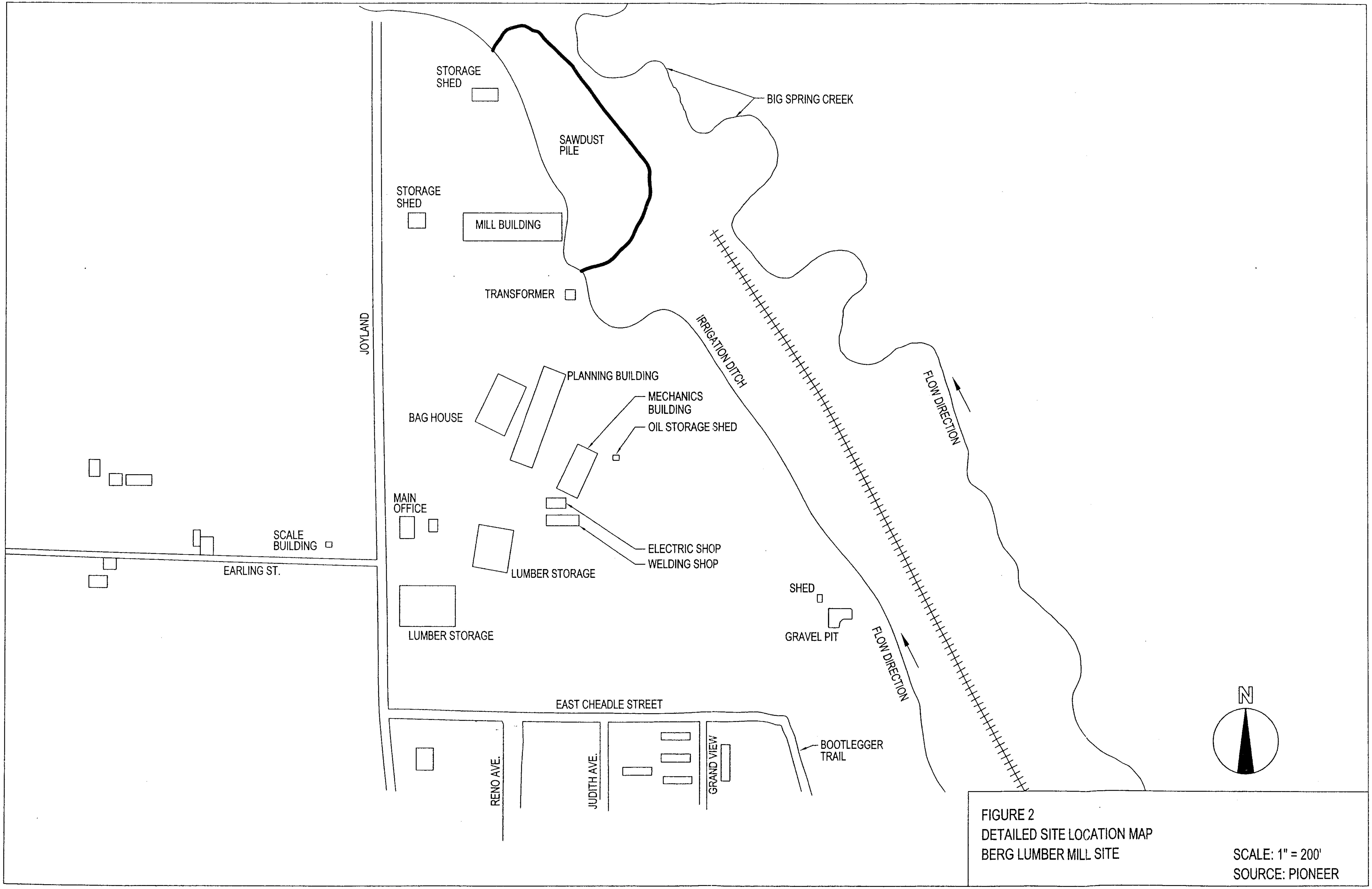


FIGURE 2
DETAILED SITE LOCATION MAP
BERG LUMBER MILL SITE

SCALE: 1" = 200'
SOURCE: PIONEER

The monitoring wells installed in 2004 indicated that groundwater occurs at depths of approximately 8-30 feet below ground surface (bgs). The lithology in the area consists of 2 to 10 feet of silty sand and gravel followed by 5 to 10 feet of weathered silty shale, followed by unweathered hard shale. Most residential wells in the area are completed in the Mowery Formation. The groundwater elevations recorded in 2004 indicate that groundwater in the uppermost aquifer flows to the northeast and discharges to Big Spring Creek.

## 1.4 Previous Environmental Investigations

Beginning in 1986, local and state investigations have been conducted at or in the vicinity of the BLMS and along Big Spring Creek, and are outlined below:

- In 1986 FWP collected fish tissue samples along portions of Big Spring Creek. Elevated concentrations of polychlorinated biphenyls (PCBs) (0.11 to 0.37 parts per billion [ppb]) and DDT (10 to 60 ppb) were found in the fish. Subsequently, the Montana Department of Health and Environmental Sciences (DHES) issued a public health advisory recommending that consumption of fish from Big Spring Creek be limited to one meal per month. These samples appear to have been collected upstream from BLMS. FWP has since determined that the PCB source was marine paint used at this fish hatchery. FWP is acting as lead agency for the PCB issue.

- In 1993 a complaint was filed with ENF regarding a white substance coming out of a culvert at BLMS. In response to the complaint, ENF collected a surface water sample from a culvert discharge, and analyzed it for common ions. ENF concluded that the white substance was a precipitate of carbonate salts.

- In 1997 FWP and Lewistown residents assisted by the Montana Bureau of Mines and Geology (BMG) collected 13 sediment samples from Big Spring Creek. PCBs were detected in four sediment samples (19.3 to 52 ppb) collected adjacent to the Brewery Flats facility. All the samples in this study were collected upstream of BLMS.

- The October 16, 2001, EA conducted by Pioneer for BLMS reported numerous barrels, buckets, and storage tanks with unknown contents, and petroleum hydrocarbons and PCP in top 2 feet of soil on the BLMS property.

- DEQ's Total Maximum Daily Load (TMDL) program collected surface water samples from Big Spring Creek in 2001 and 2003. Surface water was analyzed for nitrogen and phosphorus.

- In response to public concern about the white substance at the BLMS culvert and milky-colored pond water on BLMS property near Big Spring Creek, DEQ's Groundwater Remediation Program and DEQ ENF conducted surface water and sediment sampling on August 21, 2003. Samples were analyzed for an extensive suite of parameters. As in the 1993 ENF investigation, DEQ in 2003 concluded that the white substance is very likely a precipitate of carbonate minerals. Coliform bacteria were detected in the culvert discharge. PCP was found at 0.0024 parts per million (ppm) in the sediment sample, just above the method detection limit of 0.002 ppm. Iron was detected above its DEQ-7 Montana Numeric Water Quality Standard in the pond water samples. Manganese was found above its DEQ-7 standard in the culvert discharge sample and pond water samples. Additional sampling for PCP and coliforms was recommended.

- In August 2004, sampling of surface water, sediment, groundwater, and soil took place. The sampling was conducted under the *Berg Lumber Phase II Site Investigation Sampling and Analysis Plan*, (DEQ 2004). The results of this event are summarized in the *Report of Findings for the Berg Lumber Mill Site* (Environmental Consulting, 2005). A summary of these results can be found in Section 1.5 below.

## 1.5 Environmental and/or Human Impact

Concentrations of numerous organic compounds at the site exceed EPA Region 9 PRGs, EPA Region 9 SSLs, or Montana RBSLs. Petroleum hydrocarbon fractions ($C_9$ – $C_{18}$ and $C_{19}$ – $C_{36}$ aliphatics and $C_{11}$-$C_{22}$ aromatics) exceed residential RBSLs in surface soils and are currently threatening beneficial uses, human health, and groundwater. PCP exceeded the SSL (with a dilution attenuation factor of 10) of 0.01 ppm in 6 of the 13 surface soil samples collected. The subsurface soil samples collected during the 2004 sampling event indicated that of the 14 test pit soil samples and 5 borehole soil samples collected, four of the samples showed that PCP exceeds the SSL of 0.01 ppm with the highest reported concentration at 30 ppm. Based on the DEQ action levels being used at this time, PCP and dioxins in the soil appear to pose an unacceptable risk to human health, and PCP appears to pose an unacceptable risk of migration to groundwater. Any contaminants present in the shallow groundwater have the potential to migrate into Big Spring Creek, and could affect surface water quality as well as pose a threat to organisms living in the creek. The petroleum hydrocarbons and PCP were associated with both stained and unstained areas. Because of the presence of PCP contamination discovered, dioxins and furans were also assessed and found to exceed residential and industrial PRGs in some areas of the BLMS.

The work outlined in this SAP will be performed to determine the following: 1.) the extent and magnitude of PCP, dioxin/furan, and petroleum-contaminated soils at BLMS; 2.) whether or not manganese concentrations in groundwater at the site exceed DEQ-7 standards due to natural occurrence; and 3.) determine the hydraulic conductivity by performing slug tests on three monitoring wells.

## 1.6 Assurance of Future Redevelopment/Reuse of the Site

Please see Appendix C regarding this topic.

## 1.7 Benefits of Redevelopment/Reuse of the Site

The site in its current condition may pose an unacceptable risk to potential residential use, workers, and recreational users of the property. Because the extent of contamination has not been determined, resale and reuse of the property has been hindered. Evaluation and eventual cleanup of the site will mitigate risk to acceptable levels, thus allowing ownership of the property to be transferred and the site to be used.

Public benefit will take two forms: first, the Trustee has proposed to grant an easement on BLMS property to the City of Lewistown for use as a park and/or fishing access area near Big Spring Creek (See the Appendix C regarding this subject); and second, cleanup of the site will allow reuse and/or redevelopment of the site.

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# Section 2
# Project Data Quality Objectives

## 2.1 Data Uses

Soil samples will be collected from numerous locations at the site (see Figure 3). The sampling will be divided into two tiers of priority. Tier 1 samples will consist of samples and data that are critical to delineate the extent and magnitude of pentachlorophenol and dioxin contamination and to provide adequate information for determining a site-specific cleanup level of PCP. Tier 2 sampling locations and data will comprise of samples that are "confirmation" samples or are primarily focused on delineating petroleum hydrocarbon contamination. The second tier of samples will not be conducted in conjunction with the first tier due to funding limitations, but DEQ may require these samples to be collected in the future.

Analyses will include Extractable Petroleum Hydrocarbons (EPH), EPH fractions, PCP, dioxins and furans, and VPH. The data will be used to evaluate the extent and magnitude of contamination, and assess what remedial actions may be appropriate to clean up the site. Remedial action objectives will then be identified or validated based on the outcome (see the Data Quality Objectives table in Appendix F). Previous data were collected from areas of stained soil and non-stained soil, and samples were analyzed for PCP, EPH screen, EPH fractions, VPH, volatile organic compounds (VOCs), Semivolatile organic compounds (SVOCs) and polynuclear aromatic hydrocarbons (PAHs).

A monitoring well is to be installed (see Figure 3). This monitoring well will be used by DEQ to collect a groundwater sample to be analyzed for manganese. Previous groundwater samples indicated that levels of manganese exceeded DEQ-7 standards. The groundwater sampling will aid in the determination of whether or not the manganese concentrations are a result of on-site activities or represent background concentrations.

Three existing monitoring wells at BLMS, (BL-MW-02, BL-MW-03, and BL-MW-04) will be used to conduct slug tests. The slug tests will be used to determine the hydraulic conductivity at the site. This data will assist with the assessment of contaminant migration and calculation of site-specific cleanup goals.

Specific data quality objectives are spelled out in the Data Quality Objectives Table in Appendix F.

## 2.2 Expected Data Quality

The Quality Assurance/Quality Control (QA/QC) practices and analytical methods will be designed to produce data of such a quality that the results can be compared to DEQ RBSLs, DEQ-7 Standards, and EPA Region 9 SSLs and PRGs (collectively referred to as "DEQ Action Levels"). The data also must be of sufficient quality that decisions regarding cleanup can be based upon them. Quality of data will be assured

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**Figure 3**
**Sample Locations**
Sampling and Analysis Plan
Berg Lumber Mill Site, Lewistown, Montana

0 50 100 200 300 400 500 Feet

1 inch equals 75 feet

November 2006

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by selecting appropriate analytical methods with Method Reporting Limits below the relevant DEQ Action Levels (see Tables 3-4); using appropriate sample collection methods; collecting appropriate duplicates and blanks; reviewing laboratory reports; and adequately designing the sampling plan. Each of these data quality elements will be discussed later in the document.

Decision Error Tables (DETs) have been developed for known contaminants of concern, including the EPH fractions and PCP, and can be found in Appendix F.

## 2.3 Data Quality Indicators

Data assessment criteria will be used to evaluate the quality of the field sampling and laboratory performance for the sampling event, and are expressed in terms of analytical precision, accuracy, representativeness, completeness, and comparability, which are described in detail below.

### 2.3.1 Precision

Precision is the measure of variability among individual sample measurements under prescribed conditions. The results of laboratory control samples (LCS) demonstrate the precision of the methods. When the LCS results meet the specified accuracy criteria, results are believed to be precise. This is based on the LCS being within control limits in comparison to LCS results from previous analytical batches of similar methods and matrices. The relative percent difference (RPD) of field duplicate, laboratory sample duplicate, and matrix spike/matrix spike duplicates (MS/MSD) results demonstrate the precision of the sample matrix. Precision will be expressed in terms of RPD between the values resulting from duplicate analysis. RPD is calculated as follows:

$$RPD = [(x1 - x2)/X][100]$$

where:

| | | |
|---|---|---|
| where: | x1 | = analyte concentration in the primary sample |
| | x2 | = analyte concentration in the duplicate sample |
| | X | = average analyte concentration in the primary and duplicate sample. |

Acceptable levels of precision will vary according to the sample matrix, the specific analytical method, and the analytical concentration relative to the method detection limit (MDL). For field duplicate samples, the target RPDs are 20 percent for water samples and 35 percent for soil.

### 2.3.2 Accuracy

Accuracy is a measure of the closeness of a reported concentration to the true value. Accuracy is expressed as a bias (high or low) and is determined by calculating percent recovery (%R) from MS/MSDs, LCSs, and surrogate spikes. MS/MSD and surrogate spike %Rs indicate accuracy relevant to a unique sample matrix. LCS %Rs indicate accuracy relevant to an analytical batch lot, and are strictly a measure of analytical accuracy conditions independent of samples and matrices. The %R of an analyte, and the resulting degree of accuracy expected for the analysis of QC spiked samples, are dependent upon the sample matrix, method of analysis, and the compound or element being measured. The concentration of the analyte relative to the detection limit of the method also is a major factor in determining the accuracy of the measurement.

Accuracy is expressed as %R and is calculated as follows:

$$\%R = [(A-B)/C] \times 100$$

where: A = spiked sample concentration

B = measured sample concentration (without spike)

C = concentration of spike added.

Acceptable QC limits for %R are 80 percent to 120 percent for LCSs, method-defined for surrogates, and laboratory-defined for MS/MSDs. Chemical analytical data will be evaluated for accuracy using surrogates, MS/MSDs, and LCSs, as applicable.

### 2.3.3 Completeness

Completeness is defined as the percentage of laboratory measurements judged to be valid on a method-by-method basis. Valid data are defined as all data and/or qualified data considered when meeting the Data Quality Objectives (DQO) for this project. Data completeness is expressed as percent complete (PC) and should be 90 percent or higher. The goal for meeting analytical holding times is 100 percent. At the end of the sampling event, the completeness of the data will be assessed. If any data omissions are apparent, the parameter in question will be resampled and /or reanalyzed, if feasible. The laboratory results will be monitored as they become available to assess laboratory performance and its effect on data completeness requirements. When appropriate, additional samples will be collected to ensure that laboratory performance meets PC requirements.

PC is calculated as follows:

$$PC = NA/NI \times 100$$

where: NA = Actual number of valid analytical results obtained

NI = Theoretical number of results obtainable under ideal conditions.

### 2.3.4 Comparability

Comparability expresses the confidence with which data from one sample, sampling round, site, laboratory, or project can be compared to those from another. Comparability during sampling is dependent upon sampling program design and time periods. Comparability during analysis is dependent upon analytical methods, detection limits, laboratories, units of measure, and sample preparation procedures.

Comparability is determined on a qualitative rather than quantitative basis. For this project, comparability of all data collected will be ensured by adherence to standard sample collection procedures, standard field measurement procedures, and standard reporting methods, including consistent units.

In addition, to support the comparability of fixed-base laboratory analytical results with those obtained in previous or future testing, all samples will be analyzed by EPA-approved methods. The EPA-recommended maximum permissible holding times for organic or inorganic parameters will not be exceeded. All analytical standards will be traceable to standard reference materials. Instrument calibrations will be performed in accordance with EPA method specifications, and will be checked at the frequency specified for the methods. The results of these analyses can then be compared with analyses by other laboratories and/or with analyses for other sites.

### 2.3.5 Representativeness

Representativeness expresses the extent to which collected data define actual site contamination. Where appropriate, sample results will be statistically characterized to determine the degree to which the data accurately and precisely represent a characteristic of a population, parameter variation at a sampling point, a process, or an environmental condition. Sample collection, handling, and analytical procedures will strive to obtain the most representative sample possible. Representative samples will be achieved by collection of samples from locations fully representing site conditions. Factors that affect representativeness include:

- Use of appropriate sampling procedures, including equipment and equipment decontamination and sampling holding temperatures
- Use of appropriate analytical methods for the required parameters and project reporting limits
- Analysis of samples within the required holding times

The portion of each collected sample that is chosen for analysis also affects sample representativeness. The laboratory will adequately and appropriately homogenize all samples prior to taking aliquots for analysis to ensure that the reported results are representative of the sample received.

## 2.4 Data Management

### 2.4.1 Sample Identification System

Each sample will be assigned a unique sample identification that will distinguish it from other samples.

- Soil samples from <u>test pits</u> will be labeled as follows: **BL-TPXX-YY** where BL stands for Berg Lumber, TP stands for "test pit," XX is the numbered identifier for the test pit (i.e. 01 through 36), and YY is the depth of the sample in inches.

- Soil samples from boreholes will be labeled as follows: **BL-BHXX-YY**

where BL stands for Berg Lumber, BH stands for "bore hole," XX is the numbered identifier of the borehole (i.e. 01 through 17), and YY is the depth of the sample in feet.

- QC field duplicate samples will be assigned their own separate coded sampling locations (XX) so that the integrity of the samples is insured.

### 2.4.2 Sample Containers and Labels

New, unopened bottles or jars will be used to collect the samples. See Table 2-1 for sampling container details. Appropriate preservative will be added to the bottle in the laboratory (prior to sampling) or in the field immediately prior to or after sample collection. The container lids will be tightly closed and will not be removed at any time prior to sample collection, except for addition of preservatives. The sample label will be firmly attached to the container and the following information will be legibly and indelibly written on the label:

- Sample identification
- Facility name
- Sampling date
- Sampling time
- Analysis to be performed
- Preservatives added
- Sample collector's initials

### 2.4.3 Sample Shipment

After the samples are sealed and labeled, they will be packaged for transport to an approved analytical laboratory. Samples will be packed and shipped on ice to ensure they reach the laboratory at 2-6 degrees Celsius. Samples will be shipped overnight or hand delivered to the laboratory. The following packaging and labeling procedures will be followed:

- Package sample so that it will not break, leak, spill, or evaporate from its container
- Place all glass containers in bubble wrap bag and/or netting
- Label shipping container with:
  - Sample collector's name, address, and telephone number

- Laboratory's name, address, and telephone number
- Description of sample
- Quantity of sample
- Date of shipment

The packaged samples will be delivered to the laboratory as soon as possible after sample acquisition, and in accordance with analytical method-specific holding times. Dioxin/furan samples will be shipped overnight to the laboratory.

**Table 2-1**
**Container/analysis/preservative/holding time information**

| Analysis | Matrix | Container Type | Preservative | Holding Time |
|---|---|---|---|---|
| EPH | Soil | 1-125 ml glass jar | Chill to 4ºC | 7 days |
| PCP/ 8151A | Soil | 1-125 ml wide mouth glass/Teflon jar | Chill to 4ºC | 14 days |
| Dioxins and Furans/ 8290 | Soil | 8-oz. Amber glass | Chill to 4ºC | 30 days |
| Volatile Petroleum Hydrocarbons (Jan 1998 MDEP) | Soil | 1-125 ml glass wide mouth jar | Chill to 4ºC | 7 days to extraction, 28 days to analysis |

**Table 2-2**
**DEQ Action Levels compared to Method Reporting Limit for contaminants.**

| Media and Contaminant | DEQ-7 Standard | EPA Region 9 PRG (residential soil) | EPA Region 9 SSL (DAF 10) | Method | Method Reporting Limit |
|---|---|---|---|---|---|
| Soil /PCP | NA | 3.0 ppm | 0.01 ppm | 8151A | 0.002 ppm |
| Soil/Dioxins and Furans | NA | 3.9 ppt | NA | 8290 | 1-10 ppt |
| Soil/VPH* | NA | NA | NA | Mass. Method | * |
| Soil/EPH** | NA | NA | NA | Mass. Method | ** |

NA = Not Applicable
* VPH contaminants and respective Risk-Based Screening Levels (RBSLs) are listed in DEQ's October 2003 Risk-Based Corrective Action (RBCA) document. DEQ requires the Massachusetts Method for VPH analysis as this method's Reporting Limits are at or below the RBSLs for the VPH contaminants. See Appendix E for complete RBSL lists.
** EPH contaminants and respective RBSLs are listed in DEQ's October 2003 RBCA document. DEQ requires the Massachusetts Method for EPH analysis as this method's Reporting Limits are at or below the RBSLs for EPH contaminants. See Appendix E for complete RBSL lists.

### 2.4.4 Chain of Custody Control

During and after sampling until the time of sample shipment, samples will be in the "custody" of the sampler or samplers. "Custody" refers to the samples being in the immediate care of the field personnel, either in physical possession, immediate view, locked up, or held in a secure area restricted to authorized personnel. Samples that are shipped will have a custody seal placed on the cooler or container that will indicate if the container has been opened. After the samples have been collected, chain-of-custody procedures will be followed to establish a written record of sample handling and movement between the sampling site and the laboratory. Each shipping container will have a chain-of-custody form completed in duplicate by the sampling personnel. The sampling team will keep one copy of this form and the other copy will be sent to the laboratory. The chain-of-custody will contain the following information:

- Sample identification numbers
- Sample collector's printed name and signature
- Date and time of collection
- Sample matrix
- Analyses requested
- Signatures of individuals involved in the chain of possession
- Inclusive dates of possession.
- If sample was preserved Y/N

The chain-of-custody documentation will be placed inside the shipping container so that it will be immediately apparent to the laboratory personnel receiving the container, but will not be damaged or lost during transport. The shipping container will be sealed so that it will be obvious if the seal has been tampered with or broken.

### 2.4.5 Sampling Records

In order to provide complete documentation of the sampling event, detailed records will be maintained by the field personnel. If warranted, the records may include photographs and a photo log. These records will be recorded in the field logbook. These records will include the following information:

- Sample location (site name)
- Sample identification
- Sample location map, detailed sketch, or GIS coordinates
- Date and time of sampling
- Weather conditions
- Sampling method
- Identification of sampler, and of other individuals present
- Field observations of:
  - Sample appearance

- Sample odor

- Soil color, texture, and moisture (if sampling soil)

- Any other relevant information.

# 2.5 Assessment Oversight

As a check on the quality of field sampling activities (sampling, containerization, shipment, and handling), field duplicates will be sent to the laboratory. Other QA/QC procedures include decontamination of measuring and sampling equipment, use of analyte-appropriate containers, and chain-of-custody procedures for sample handling and tracking.

A five-percent frequency (one sample for every twenty environmental samples collected) applies to field duplicates. The procedures for the collection of field QA/QC samples are described in Section 7. The laboratory should plan to conduct one matrix spike analysis, one laboratory control sample, and one laboratory blank test for each specific analysis requested. Data that do not meet data quality objectives will be flagged, and the reason for flagging will be described.

## 2.5.1 Field Quality Assurance/Quality Control Samples

As a check on field sampling, QA/QC samples will be collected during each sampling event. Definitions for field QA/QC samples are presented below.

### Field Duplicates

A field duplicate is defined as two or more samples collected independently at the same sampling location during a single act of sampling. Field duplicates will be indistinguishable from other samples by the laboratory. Each of the field duplicates will be uniquely identified with a coded identifier, which will be in the same format as other sample identifiers. Duplicate sample results are used to assess the precision of the sample collection process. Five percent (one for every 20 samples) of all field samples will be field duplicates. For the Tier 1 sampling, one duplicate soil sample will be collected from Test Pit BL-TP11 and from Boreholes BL-BH03 (5 foot depth), BL-BH04 (2 foot depth) and BL-BH06 (15 foot depth). One soil sample duplicate will be collected from Test Pit BL-TP25 for the Tier 2 sampling event.

## 2.5.2 Field Data Quality Assurance/Quality Control Procedures

The following sections describe field analytical instrumentation calibration, and field data reporting, validation, reduction, and review.

## 2.5.3 Calibration Procedures and Frequency for Field Test Equipment

Instruments and equipment used to gather, generate, or measure environmental data in the field will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Field instruments may include a photoionization detector (PID) and a water level probe. Directions and spare parts (such as probes) for each meter will be available in the field. Ample calibration solutions and/or gases will also be present.

## 2.5.4 Review of Field Records

All field records are evaluated for the following:

**Completeness of field records.** The check of field record completeness will ensure that all requirements for field activities have been fulfilled, complete records exist for each field activity, and that the procedures specified in the SAP (or approved as field change requests) were implemented. Field documentation will ensure sample integrity and provide sufficient technical information to recreate each field event. The results of the completeness check will be documented, and environmental data affected by incomplete records will be identified in the technical report.

**Identification of valid samples.** The identification of valid samples involves interpretation and evaluation of the field records to detect problems affecting the representativeness of environmental samples. For example, field records can indicate whether monitoring points were properly constructed or if unanticipated environmental conditions were encountered during construction. The lithologic and geophysical logs may be consulted to determine if a point is screened only in the water-bearing zone of concern. Records also should note sample properties such as clarity, color, odor, etc. Photographs may show the presence or absence of obvious sources of potential contamination, such as operating combustion engines near a point during sampling. Judgments of sample validity will be documented in the technical report, and environmental data associated with poor or incorrect fieldwork will be identified.

**Identification of anomalous test data.** Anomalous field data will be identified and explained to the extent possible. For example, a water temperature for one point that is significantly higher than any other point temperature in the same aquifer will be explained in the technical report.

**Accuracy and precision of data and measurements.** The assessment of the quality of field measurements will be based on instrument calibration records and a review of any field corrective actions.

## 2.5.5 Data Validation and Reporting

All screening data will be reviewed prior to reporting. The project officer will determine if the DQOs for data have been met. At a minimum, the review of screening data will focus on the following topics:

- Holding times
- Method blanks

- Comparison of field duplicates
- Field instrumentation detection limits
- Analytical batch control records including calibrations, and spike recoveries
- Flag all results with an "S" to denote sample results from field screening versus fixed laboratory results.

Data will be validated using four different procedures, as described below:

- Routine checks (e.g., looking for errors in identification codes) will be made during the processing of data.
- Internal consistency of a data set will be evaluated. This step will involve plotting the data and testing for outliers.
- Checks for consistency of the data set over time will be performed. This can be accomplished by comparing data sets against gross upper limits obtained from historical data sets, or by testing for historical consistency. Anomalous data will be identified.
- Checks may be made for consistency with parallel data sets. An example of such a check would be comparing data from the same region of the aquifer or volume of soil.
- Checks may be made by comparing field results to laboratory results. For example, plotting PID field results against laboratory results for volatiles.

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# Section 3
# Sampling Program

## 3.1 Soil

The purpose of the test pit and borehole soil sampling is to determine the depth and extent of contamination. Approximate locations of soils samples are indicated on Figure 3. Exact soil sampling locations will be determined in the field based on accessibility, visible signs of potential contamination, and topographical features which may indicate locations of hazardous substance disposal. Soil sample locations will be recorded in the field logbook as sampling is completed. A sketch of the sample location will be entered into the logbook and any physical reference points will be labeled. If possible, distances to the reference points will be given. GIS coordinates will be taken and recorded in the log book.

Both surface soil and subsurface soil samples will be collected. Please note that any definitions or description of surface soil and subsurface soil in the SAP text supersedes those in the attached SOPs (Appendix B).

### 3.1.1 Test Pits Sampling Locations

Up to 32 test pits will be dug at the BLMS. Refer to Figure 3 for specific locations. These locations have been chosen because the depth of petroleum hydrocarbon and PCP contamination has not been defined in these areas. Two samples per test pit location will be collected. The first sample will be collected from the top 6" of soil, and if sod is present, from the top 6" of soil under the sod. The first sample will be a composite of 5 subsamples (four corners of a square and a point in the middle). Subsamples will be collected with a trowel and thoroughly mixed together in a clean stainless steel bowl with a trowel or spoon. At a few locations (see Table 3-1), samples will be analyzed for VPH because previous sampling showed VPH compounds in the area. If a VPH analysis is required, the sample will be placed into the appropriate sample container, and mixing the sample will be performed by the laboratory.

The test pits will then be advanced to 24-inches or to where the backhoe cannot advance the hole further. A PID will be used to assess the level of volatile contamination at different depths in the pit, in concert with visual observation of staining. This activity will determine the vertical extent of the impacted soil. A 5-point composite sample will then be collected at the interval of 6-24 inches deep. All soil samples will be analyzed for EPH screen using MAEPH and selected samples will be analyzed for PCP via Method 8151A, VPH using Massachusetts method MAVPH and dioxins/furans via method 8290 (see Figure 3 and Table 3-1). If the EPH screen produces a Total Extractable Hydrocarbon (TEH) value exceeding 50 ppm, then EPH fractionation will be run and the sample will also be analyzed for Polynuclear Aromatic Hydrocarbons (PAHs) via Method 8270. These analytical methods have been chosen because the contamination causing the staining has been shown to be petroleum hydrocarbon in nature, likely spills of diesel and lubricating oils. PCP has been shown to be present in these stained areas as well, particularly in the vicinity of the former wood treating area, which makes sense given that PCP was frequently mixed with diesel for treating wood. See Appendix D for the field forms for the test pit sampling.

Initial locations of test pits will be located using a GPS unit. Prior to digging, the test pit locations will be marked in the field with a wooden stake or flagging and labeled with the test pit identification. All test pit locations will be recorded with GPS coordinates after completion for future reference. Field duplicate samples will be taken from test pits 11 and 25.

**Table 3-1**
**Analysis for Test Pit Samples**

| Test Pit ID | PCP | Dioxin/Furan | EPH Screen | VPH |
|---|---|---|---|---|
| **TIER 1** | | | | |
| BL-TP01- | X | X | X | -- |
| BL-TP02- | X | X | X | -- |
| BL-TP03- | X | X | X | -- |
| BL-TP04- | X | X | X | -- |
| BL-TP05- | X | X | X | -- |
| BL-TP06- | X | X | X | -- |
| BL-TP07- | X | X | X | -- |
| BL-TP08- | X | X | X | -- |
| BL-TP09- | X | X | X | -- |
| BL-TP10- | X | X | X | -- |
| *****BL-TP11- | X | X | X | -- |
| BL-TP12- | X | X | X | -- |
| BL-TP13- | X | X | X | -- |
| BL-TP14- | X | X | X | -- |
| BL-TP15- | X | X | X | -- |
| BL-TP16- | X | X | X | X |
| **TIER 2** | | | | |
| BL-TP17- | -- | -- | X | X |
| BL-TP18- | -- | -- | X | -- |
| BL-TP19- | -- | -- | X | -- |
| BL-TP20- | -- | -- | X | -- |
| BL-TP21- | -- | -- | X | -- |
| BL-TP22- | -- | -- | X | -- |
| BL-TP23- | -- | -- | X | -- |
| BL-TP24- | -- | -- | X | X |
| *****BL-TP25- | -- | -- | X | -- |
| BL-TP26- | -- | -- | X | -- |
| BL-TP27- | -- | -- | X | -- |
| BL-TP28- | -- | -- | X | -- |
| BL-TP29- | -- | -- | X | -- |
| BL-TP30- | -- | -- | X | -- |
| BL-TP31- | -- | -- | X | -- |
| BL-TP32- | -- | -- | X | -- |

* indicates duplicate samples will be taken from these test pits.

## 3.1.2 Borehole Soil Sampling

Seven boreholes will be installed during the Tier 1 sampling event for collection and analysis of soil samples. One of the boreholes will be completed as a monitoring well (BL-MW05). Refer to Figure 3 for approximate borehole and monitoring well locations. The boreholes will be installed to a depth of 30 ft bgs. All of the boreholes will be installed near the southeast corner of the property (Figure 3) which is in the area of the former wood treating area. Previous sampling results in this area have shown that PCP contamination is present. The purpose of these seven boreholes is to help verify to what depth the PCP contamination extends.

Boreholes will be advanced with a hollow stem auger drill rig with a split spoon. Soil characteristics will be logged, and samples will be collected at depths of 0-6", 6-24", 5', 10', 20' and 30'. Depending on the location of the boreholes, the samples will be analyzed for all or some of the following: EPH screen; PCP via Method 8151A; and dioxins/furans via method 8290 (see Figure 3 and Table 3-2). See Appendix D for field forms for the borehole sampling. Up to six opportunistic samples may be collected and analyzed for Dioxin/Furans depending on visual inspection of borings. Visual observation will include examining the soils from the borehole intervals for the presence of soil staining. If staining is present, samples may be collected.

**Table 3-2**
**Analysis for Borehole Samples**

| Borehole ID | PCP | Dioxin/Furan | EPH Screen | Duplicate |
|---|---|---|---|---|
| BL- BH 01- | 0-6", 6-24", 5', 10', 20', 30' | 0-6", 6-24",10',30' | 0-6", 6-24",10',30' | |
| BL- BH 02- | 0-6", 6-24", 5', 10', 20', 30' | 0-6", 6-24",10',30' | 0-6", 6-24",10',30' | |
| BL- BH 03- | 0-6", 6-24", 5', 10', 20', 30' | 0-6", 6-24",10',30' | 0-6", 6-24",10',30' | |
| *****BL- BH 04- | 0-6", **6-24"**, 5', 10', 20', 30' | 0-6", **6-24"**,10',30' | 0-6", **6-24"**,10',30' | At 6-24" Depth |
| BL- BH 05- | 0-6", 6-24", 5', 10', 20', 30' | 0-6", 6-24",10',30' | 0-6", 6-24",10',30' | |
| BL- BH 06- | 0-6", 6-24", 5', 10', 20', 30' | 0-6", 6-24",10',30' | 0-6", 6-24",10',30' | |
| *****BL-MW05 | 0-6", 6-24", 5', **10'**, 20', 30' | 0-6", 6-24",**10'**,30' | 0-6", 6-24",**10'**,30' | At 10' Depth |

***** indicates duplicate samples will be taken from these boreholes
**Bold** indicates the depth at which duplicate will be collected

# 3.2 Monitoring Well

As mentioned in Section 3.1.2, a 2-inch monitoring well will be installed at the southeast corner of the property. A 20-foot screen will be utilized and set at 5 feet above static water level. The boring from this location will be utilized for soil sampling as described in Section 3.1.2. The monitoring well will be installed and developed in accordance with SOP 4-3 and SOP 4-4 (See Appendix B).

After the installation of the monitoring well, coordinates and elevation of the well will be surveyed by a licensed surveyor.

# 3.3 Slug Testing

Slug testing will be conducted on existing monitoring wells BL-MW-02, BL-MW-03, and BL-MW-04. Currently, the well stick-up for monitoring well BL-MW-02 is damaged and prior to conducting the slug test this monitoring well will be repaired. This information will be used to determine the hydraulic conductivity at the site. The gathering of this data will be helpful in determining rates of contamination migration. The slug test procedure can be found in Appendix B.

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# Section 4
# Methods And Procedures

## 4.1 Field Health and Safety Procedures

One DEQ project officer and 1-2 DEQ-hired consultants/contractors will conduct the sampling. The team will have a designated site safety officer, as indicated in the health and safety plan (HASP) in Appendix A . Field safety procedures, including safety equipment and clothing, hazard identification, and the location and route to the Lewistown hospital, are included in the HASP. A first aid kit and appropriate personal protective equipment will be taken to the field.

## 4.2 Field Procedures

### 4.2.1 Test Pits

**Equipment for both Tiers of Sampling**

- Backhoe or bobcat for digging pits and moving site debris if required
- PID meter and plastic ziptop bags
- Plastic measuring tape to measure pit depth and location
- Disposable or washable scoops, trowels, or spoons
- Nitrile sampling gloves
- 1 Environmental Field Book
- Pre-printed field log sheets and metal clipboard
- 4 indelible ink pens
- Plastic trash bags
- Stainless steel bowl or plastic buckets
- Deionized water
- Tap water
- Methanol Solution
- Non-phosphate (liquinox) detergent
- Scrub brushes
- Paper towels
- Camera and film
- 40- Painted stakes and hammer or flagging and nails for marking test pit locations
- 1 permanent black marker for marking painted stakes
- coolers filled with ice

**Tier 1 Sampling Event**

- 40-125 ml glass jars, labeled for EPH
- 10-125 ml glass jars, labeled for VPH
- 40- 125 ml glass jars, labeled for PCP/8151A
- 40- 8oz. amber glass jars with labels for dioxins and furans/8290
- Five 55-gallon drums

**Tier 2 Sampling Event**

- 40-125 ml glass jars, labeled for EPH
- 10-125 ml glass jars, labeled for VPH
- Five 55-gallon drums

### 4.2.2 Boreholes

**Equipment**

- Hollow stem auger drill rig with split spoon sampler
- Stainless steel bowl or plastic buckets for homogenizing samples
- Disposable or washable scoops, trowels, or spoons for mixing
- 40- 125 ml glass jars with labels for EPH
- 50- 125 ml glass jars with labels for PCP/8151A
- 40- 8oz. amber glass jars with labels for dioxins and furans/8290
- Nitrile sampling gloves
- 1 Environmental Field Book
- Pre-printed field log sheets and metal clipboard
- 4 indelible ink pens
- Plastic trash bags
- Tap water in jug and spray bottle
- Methanol solution in spray bottle
- Deionized water in spray bottle and jug
- Non-phosphate (liquinox) detergent in spray bottle and concentrate
- Paper towels
- Camera and film
- Coolers filled with ice
- 20- Painted stakes and hammer or flagging and nails for marking borehole locations
- 1 permanent black marker for marking painted stakes
- Twenty 55-gallon drums

### 4.2.3 Slug Testing

- Water level measurement indictor or tape
- Pressure transducer probe
- Electronic data logger data transfer cables
- Slug, bailer, or water of known quality to inject into well
- Twine or rope for lowering/raising slug
- Fastening devices for securing pressure transducer at discrete level in well
- Watch with second display or stopwatch function
- Knife or scissors, leatherman tool
- Nitrile sampling gloves
- 1 Environmental Field Book
- Pre-printed field log sheets and metal clipboard
- 4 indelible ink pens
- Calculator
- Plastic trash bags
- Graduated plastic bucket
- Deionized water
- Non-phosphate detergent
- Scrub brushes
- Paper towels

- Camera and film

### 4.2.4 Equipment Calibration and Maintenance

Instruments and equipment used to gather, generate, or measure environmental data in the field will be calibrated with sufficient frequency and in such a manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Field instruments may include a photoionization detector and a water level indicator.

## 4.3 Field Sampling Procedures

### 4.3.1 Test Pit Soil Sampling

The backhoe or other similar equipment will excavate a pit in the areas as marked in the field. The smallest available bucket will be used to minimize soil disturbance. Soil from the test pits will be stockpiled on plastic to prevent any cross contamination of surrounding surface soil. Depth of staining, if any, will be noted in the test pit. Soil samples for field screening with a PID will be collected from stained and unstained soil, and the results noted. The first sample will be collected from the top 6" of soil, or if sod is present, from the top 6" of soil under the sod. The first sample will be a composite of 5 subsamples. A 5-point composite sample will also be collected from 6-24 inches and noted in the field book. The sample will be collected from the pit itself. Containers will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being closed to prevent potential contaminant migration to or from the sample. Sample containers will be closed as soon as they are filled, chilled and processed for shipment to the laboratory. Stockpiled soil will be returned to the pit from which it came. Reusable sampling equipment will be decontaminated in accordance with procedures described in Section 4.5. The backhoe bucket will be rinsed with decon water. Equipment will then air dry. Rinsate blanks will be collected as described in section 7.1.1.

The test pit soil sampling will be conducted in accordance with SOP 1-3 and SOP 1-4. These SOPs are included in Appendix B.

Soil from surface sampling activities will be replaced into the ground to the extent possible.

### 4.3.2 Borehole Soil

Subsurface soil samples will be collected by boring to the desired sample depth using a hollow stem auger drill rig, and a sample will be collected with a split-spoon sampler at depths specified in Table 3-2. These samples will be collected in accordance with SOP 1-4 (Appendix B). Samples will be transferred directly from the sampling device into a clean pail or stainless steel bowl, homogenized with a trowel, and then transferred into the appropriate container. All equipment will follow the decontamination procedures described in Section 4.5. Containers will be filled to the top, taking care to prevent soil from remaining in the lid threads prior to being closed to prevent potential contaminant migration to or from the sample. Sample containers will be closed as soon as they are filled, chilled and processed for shipment to the laboratory (See SOP 2-1 in Appendix B).

Lithologic loggings for all boreholes will be performed in accordance with SOP 3-5 (See Appendix B).

Soil from boreholes will be containerized in drums. Soil from each borehole will be containerized in its own drum and labeled with the correct borehole ID. The drums will be stored in an on-site building unless other arrangements are made. Sample results from each borehole will be used to determine if the containerized soil needs further sampling, disposal as hazardous waste or if the soils can be placed on the ground on-site.

### 4.3.3 Field Notes

All field-sampling activities will be recorded in a bound, sequentially paginated field notebook in permanent ink and/or on pre-printed field log sheets (See SOP 4-1 in Appendix B). All sample collection entries will include the date, time, sample locations and numbers, notations of field observations, the sampler's name and signature, other people present, and any deviations from the sampling plan. Field instrument calibration information will also be recorded in the logbook.

### 4.3.4 Photographs

Field-sampling activities will be documented with photographs (See SOP 4-2 in Appendix B). Field personnel taking the photographs will then record the following information in the field logbook:

- time, date, location, and weather conditions
- location and direction in which photo was taken (for example, "Looking North")
- description of the subject photographed.

## 4.4 Specific Water-Level Measurement Procedures

All field meters will be calibrated according to manufacturer's guidelines and specifications before field use, and as appropriate throughout the workday. Field meter probes will be decontaminated before and after use at each well as described in Section 4.5.

From the top of the well casing (or from a previously inscribed and indelibly marked point on the well casing) and prior to purging, all wells will be sounded for depth to water and total well depth (if depth is not known from the borehole log). An electronic sounder, accurate to the nearest +/- 0.01 feet, will be used to measure depth to water in each well. When using the electronic sounder, the probe will be lowered down the casing to the top of the water column, and the graduated markings on the probe tape will be used to measure the depth to water from the surveyed point on the rim of the well casing. Total well depth will be sounded from the surveyed top of the casing by lowering the weighted probe to the bottom of the well. The weighted probe will sink into silt, if present, at the bottom of the well screen. Total well depths will be measured to the nearest 0.1 feet. Static water levels will be reported based on surveyed well elevations.

## 4.5 Decontamination Procedures

The decontamination (decon) procedures that will be followed are in accordance with DEQ and EPA approved procedures. Decon of sampling equipment must be conducted consistently so as to assure the quality of samples collected. All equipment that comes into contact with potentially contaminated soil or water will be deconned. Disposable equipment intended for one-time use will not be deconned, but will be packaged for appropriate disposal. Decon will occur prior to and after each use of a piece of equipment. A centrally located decon station will be set up if necessary. Otherwise, decon will take place at the location which was just sampled, to prevent spread of contaminants to uncontaminated areas or to areas that have not yet been sampled. If sampling is taking place in an area of known or suspected PCP contamination, the decon fluids must be treated as an FO32 listed hazardous waste. The decon fluids will be kept to a minimum and will be containerized in 55-gallon drums. A sample will be collected from each container of decon fluid and will be analyzed for PCP, dioxin, PAHs, EPH and SVOCs. If the analysis shows levels meet cleanup goals, the container of decon fluid will not be considered hazardous and will be disposed of on-site. If levels of PCP are detected, the containerized water will either be treated on site or will be shipped off-site to be disposed of accordingly.

If the sampling is not occurring in an area of known or suspected PCP contamination, the decon fluids will be disposed of on the ground. However, if subsequent sampling results from the latter areas indicate the presence of PCP contamination, it must then be treated as an FO32 listed hazardous waste.

The following rinses, to be carried out in sequence, make up the EPA Region IX recommended procedure for the decon of sampling equipment.

- Non-phosphate detergent and tap water wash, using a brush if necessary
- Tap-water rinse
- Methanol rinse
- Deionized/distilled water rinse

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# Section 5
# Disposal Of Residual Materials

In the process of collecting soil samples from the BLMS, the DEQ/consultant site team will generate different types of potentially contaminated investigation-derived wastes (IDW) that include the following:

- Used personal protective equipment (PPE)
- Disposable sampling equipment
- Decontamination fluids
- Soil from boreholes

The EPA's National Contingency Plan (NCP) requires that management of IDW generated during sampling comply with all applicable or relevant and appropriate requirements (ARARs) to the extent practicable. The sampling plan will follow the Office of Emergency and Remedial Response (OERR) Directive 9345.3-02 which provides the guidance for the management of IDW. In addition, other legal and practical considerations that may affect the handling of IDW may be considered.

Used PPE and disposable equipment will be double bagged and placed in a municipal refuse dumpster on site (if possible). If such a dumpster is not available on site, then the double-bagged IDW will be transported to and disposed of in the DEQ dumpster located at 1100 North Last Chance Gulch, Helena, MT 59601. These wastes are not considered hazardous and may be sent to a municipal landfill. Any PPE and disposable equipment that is to be disposed of that would still be functional will be rendered inoperable before disposal in the refuse dumpster.

Decontamination fluids that will be generated in the Site Investigation (SI) will consist of dilute methanol, deionized water, residual contaminants (hydrocarbons and PCP), and water with non-phosphate detergent. The volume and concentration of the decontamination fluids will be kept to a minimum.

If sampling is taking place in an area of known or suspected PCP contamination, the decon fluids must be treated as an FO32 listed hazardous waste. The decontamination fluids will be kept to a minimum and will be containerized in 55-gallon drums. A sample will be collected from each container of decontamination fluid and will be analyzed for PCP, dioxin, PAHs, EPH and SVOCs. If the analysis shows levels meet cleanup goals, the container of decontamination fluid will not be considered hazardous and will be disposed of on-site. If levels of PCP and/or dioxin are detected at concentrations above cleanup goals, then the containerized water will either be treated on site or will be shipped off-site to be disposed of accordingly.

Surface soil sampling via test pits is proposed for locations outside of known areas of contamination. Because test pits are being advanced to two feet deep, all of which is considered to be "surface soil" by DEQ, there is little opportunity for mixing of potential contamination within the soil profile in a way that would affect overall risk. Soil from each test pit will temporarily be stockpiled on a tarp and will be immediately replaced into the hole after sample collection. Soil from boreholes will be containerized in drums. Soil from each borehole will be containerized in its own drum and labeled with the correct borehole ID. The drums will be stored in an on-site building unless other arrangements are made. Sample results from each borehole will be used to determine if the containerized soil needs further sampling, disposal as hazardous waste or if the soils can be placed on the ground on-site.

# Section 6
# Sample Documentation And Shipment

## 6.1 Sample Chain-of-Custody forms

All sample shipments for analyses will be accompanied by a chain-of-custody record. A copy of this form can be found in Appendix B. If multiple coolers are sent, a form will be filled out for each cooler. Until the samples are shipped, the custody of the samples will be the responsibility of CDM or DEQ personnel. A QA/QC summary form will be completed for each laboratory and each matrix of the sampling event. The shipping containers in which samples are stored will be sealed with self-adhesive custody seals any time they are not in someone's possession or view before shipping. All custody seals will be signed and dated.

## 6.2 Labeling, packaging, and shipping

Samples will be labeled as described in Section 2.4.2. Glass containers will be placed inside bubble-wrap bags and then into ziptop bags. All sample containers will be placed in a strong-outside shipping container/cooler. The following outlines the packaging procedures that will be followed for samples:

1. When ice is used it will be packed in ziptop, double plastic bags. The drain plug of the cooler will be sealed with fiberglass tape to prevent melting ice from leaking.

2. The bottom of the cooler will be lined with bubble wrap to prevent breakage during shipment.

3. Screw caps will be checked for tightness and, if not full, will be marked with indelible ink at the sample volume level of the outside of the sample bottles.

4. All glass sample containers will be protected by bubble wrap.

All samples will be placed in coolers with the appropriate chain-of-custody forms. All forms will be enclosed in a large plastic bag and affixed to the underside of the cooler lid. Empty space in the cooler will be filled with bubble wrap or Styrofoam peanuts to prevent movement and breakage during shipment. Bags of ice or blue ice will be placed on top and around the samples. Each ice chest will be securely taped shut with fiberglass strapping tape, and custody seals will be affixed to the front, right, and back of each cooler.

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# Section 7
# Quality Control

## 7.1 Field quality control samples

This section describes the type, number, and collection points of the quality control samples that will be collected for this sampling investigation.

### 7.1.1 Equipment Rinsate Blanks

Equipment blanks will be collected for the soil sampling portion of this sampling investigation. One equipment rinsate blank will be collected for the drill auger and one for the bucket used for the test pits for the entire soil sampling event. To collect the rinsate blank, deionized water will be passed over decontaminated equipment (backhoe bucket and drilling/sampling equipment) and collected in the appropriate bottles for analyses of PCP. These will not be submitted blind.

### 7.1.2 Field Blanks

No field blank samples will be collected during this sampling event. Because the sampling equipment is not organic, it is not anticipated that sampling procedures will introduce contamination to the samples.

### 7.1.3 Trip Blanks

One or more trip blanks will be collected for this sampling event. The laboratory will provide trip blanks. Trip blanks will be collected at a frequency of 1 in 20 (minimum of 1 per sampling event).

### 7.1.4 Field Duplicate Samples

Duplicate soil samples will be collected at sample locations shown in Table 7-1. The samples will be analyzed for one or more of the following: EPH, Dioxin/Furan, VPH and PCP. Duplicate samples will be assigned their own separate coded sampling location number so that the integrity of the samples is insured. Duplicate samples will be preserved, packaged, and sealed in the same manner as other samples of the same matrix.

**Table 7-1**
**Duplicate Sample Analysis**

| Sample ID (Duplicate ID) | PCP | Dioxin/Furan | EPH Screen | VPH |
|---|---|---|---|---|
| BL-BH04-2 (BL-BH60-2) | X | X | X | -- |
| BL-MW05-10 (BL-BH61-10) | X | X | X | -- |
| BL-TP11-2 (BL-TP50-2) | X | X | X | -- |
| BL-TP25-2 (BL-TP51-2) | -- | -- | X | -- |

## 7.2 Laboratory Quality Control Samples

Laboratory quality control samples will be administered by the laboratory. Quality Control will be based on written procedures approved by laboratory management that will be included in the laboratory's QA plan. Samples collected during this project will be analyzed in accordance with standard (e.g., EPA) and/or nationally recognized analytical procedures. The purpose of using standard procedures is to provide analytical data of known quality and consistency. The laboratory will adhere to the QC requirements specified in the applicable analytical methods. Examples of laboratory quality control samples used to evaluate laboratory performance include, but are not limited to, the following:

Method Blanks. Method blanks contain all the reagents used in the preparation and analysis of samples and are processed through the entire analytical sequence to assess spurious contamination arising from reagents, glassware, or instrument carry-over introduced during the analysis.

Calibration Check Samples. One of the working calibration standards that is periodically used to check that the original calibration is still valid (e.g., continuing calibration standard).

Laboratory Duplicates. A duplicate aliquot taken from the same sample is carried through the entire preparative and analytical sequence. Duplicate samples will also be received from the field. The results of the laboratory and field duplicate samples are used to estimate the precision of the analytical procedures.

Spiked Samples. Known amounts of a particular constituent are added to high purity laboratory-grade water or solvent, or to a field sample. The percent recovery of the added amount is used to estimate the accuracy of the analytical procedure. If laboratory-grade water or solvent is spiked, the resulting sample may be called a laboratory control sample or blank spike. If a field sample is spiked, the resulting sample is a matrix spike or surrogate spike.

Laboratory Control Sample (LCS). This sample is usually prepared from EPA Environmental Monitoring Systems Laboratory (EMSL) concentrates or National Institute of Standards and Technology (NIST) standard reference materials. The LCSs are used to establish that an instrument or procedure is in control. An LCS is carried through the entire sample preparation and analysis procedure. These samples provide an indication of whether the laboratory processes are in control, in the absence of matrix effects.

Matrix Spike (MS). One field sample (submitted to the laboratory as a triple volume sample) is divided into three aliquots. One aliquot is analyzed as is (without spiking) and the remaining two aliquots are spiked and analyzed. The percent recovery of the known spikes provides information on the accuracy of the analysis, matrix interferences, and provides an indication of the suitability of the method for the matrix.

Matrix Spike Duplicate (MSD). When two aliquots are spiked, the analytical results provide information on analytical precision as well as accuracy and matrix interferences.

Surrogate Spikes. Samples requiring analysis by GC/MS are routinely spiked with a series of deuterated analogues of the compounds of interest. These compounds are used to assess the behavior of actual analytes in individual project samples during the entire preparation and analysis sequence. Surrogate spike recoveries are also used to assess accuracy of the analysis.

## 7.3 Field Variances

As conditions in the field may vary, it may become necessary to implement minor modification to sampling as presented in this plan. Appropriate notifications will be made if necessary (Laura Alvey, DEQ Brownfields Coordinator, (406) 841-5062), and verbal approval will be obtained before implementing the changes. Modification to the approved work plan will be documented in the field logbook and also in the report of sampling activities.

Please note that all procedures and definitions described in the SAP supersede the SOPs included in Appendix B.

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# Section 8
# References

DEQ. 2004. Berg Lumber Phase II Site Investigation Sampling and Analysis Plan. April.

Environmental Consulting. 2005. Final Report of Findings for the Berg Lumber Mill Site, Lewistown, Montana. October.

Pioneer. 2001. Phase I Environmental Assessment for the Berg Lumber Company Joyland Road, Lewistown, Montana. October.

U.S. Environmental Protection Agency. 2002. EPA Region 9 Preliminary Remediation Goals with Soil Screening Levels (www.epa.gov/region09/waste/sfund/prg/files/02table.pdf).

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# Appendix A
# Health and Safety Plan

**HEALTH AND SAFETY PLAN FORM** *This document is for the exclusive use of CDM and its subcontractors* **CAMP DRESSER & McKEE INC.**

**CDM Health and Safety Program** **PROJECT DOCUMENT #:**

**PROJECT NAME** Berg Lumber Mill (a.k.a. Lewistown Groundwater Investigation) **PROJECT#** 8469-53602 **REGION** West

**SITE ADDRESS** 2 miles northwest of downtown Lewistown, on the corner of Joyland Road and East Cheadle Street

**CLIENT ORGANIZATION** Montana DEQ

**CLIENT CONTACT** Laura Alvey

**CLIENT CONTACT PHONE #** 406-841-5062

**( X ) AMENDMENT TO EXISTING APPROVED H&SP?**

**(  ) H&SP AMENDMENT NUMBER?** **( ) DATE OF APPROVED H&SP**

**OBJECTIVES OF FIELD WORK:**
**(e.g. collect surface soil samples):**

Collect soil samples utilizing test pits and borings.

**SITE TYPE:** *Check as many as applicable*

| | | | | | |
|---|---|---|---|---|---|
| Active | ( ) | Landfill | ( ) | Unknown | ( ) |
| Inactive | ( X ) | Uncontrolled | ( ) | Military | ( ) |
| Secure | ( ) | Industrial | ( ) | Other (specify) | |
| Unsecure | ( ) | Recovery | ( ) | | |
| Enclosed space | ( ) | Well Field | ( ) | | |

All requirements described in the **CDM Health and Safety Manual** are incorporated in this health and safety plan by reference.

| PERSONNEL AND RESPONSIBILITIES NAMES OF WORK CREW MEMBERS | COMPANY or DIVISION | CDM HEALTH CLEARANCE | PROJECT OR SITE RESPONSIBILITIES | Tasks On Site? |
|---|---|---|---|---|
| | | | Work Assignment Manager | 1-2-3-4-5-6 |
| | | | Site Health & Safety Coordinator | 1-2-3-4-5-6 |
| | | | 2nd Health & Safety Coordinator | 1-2-3-4-5-6 |
| | | | Site Engineer | 1-2-3-4-5-6 |
| Gwen Pozega | CDM-Helena | | Project Manager | 1-2-3-4-5-6 |
| Curt Coover | CDM-Helena | | Site Technician | 1-2-3-4-5-6 |
| | | | Subcontractor | 1-2-3-4-5-6 |

**BACKGROUND REVIEW:** ( X ) Complete ( ) Incomplete

**SITE MAP:** *Show Exclusion, Contamination Reduction, and Support Zones. Indicate Evacuation and Reassembly Points*

Please see SAP.

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**CDM Health and Safety Program** **PROJECT DOCUMENT #:**

**HISTORY:** *Summarize conditions that relate to hazard. Include citizen complaints, spills, previous investigations or agency actions, known injuries, etc.*

The Berg Lumber Mill operated a lumber mill and a wood-treating area. The site was also used to store a large sawdust pile, waste wood, and various machines and equipment. Pentachlorophenal is persent in the soil at elevated concentrations in the gravel pit area where wood was treated. Petroleum hydrocarbon stained soil is present in various smaller areas throughout the site.

**WASTE TYPES:** ( ) Liquid ( X ) Solid ( ) Sludge ( ) Gas ( ) Unknown ( ) Other, specify:

**WASTE CHARACTERISTICS:** *Check as many as applicable.*

| | | |
|---|---|---|
| ( ) Corrosive | ( ) Flammable | ( ) Radioactive |
| ( X ) Toxic | ( ) Volatile | ( ) Reactive |
| ( ) Inert Gas | ( ) Unknown | |
| ( ) Other: ______ | | |

**WORK ZONES:**

Excusion Zone - 1.5 times drill mast height of drillrig

Contamination Reduction Zone - 20 feet around exclusion zone

Support Zone - 35 feet around contamination reduction zone

**HAZARDS OF CONCERN:** *Check as many as applicable.*

| | | | |
|---|---|---|---|
| ( ) Heat Stress | CDM Guideline | ( X) Noise | CDM Guideline |
| ( ) Cold Stress | CDM Guideline | ( ) Inorganic Chemicals | |
| ( ) Explosive/Flammable | | ( X) Organic Chemicals | |
| ( ) Oxygen Deficient | | ( ) Motorized Traffic | |
| ( ) Radiological | | (X ) Heavy Machinery | |
| ( ) Biological | | ( X) Slips & Falls | CDM Guideline |
| ( ) Other: ______ | | | |
| ( ) Other: ______ | | | |

**FACILITY'S PAST AND PRESENT DISPOSAL METHODS AND PRACTICES:**

Spills occurred from wood treating area. Currently all sources of contamination have been removed.

**This plan incorporates CDM's procedure for:** *(Click on the relevant topics to download the hazard guideline. Delete irrelevant topics.)*

| | | | |
|---|---|---|---|
| Housekeeping | Traffic and Work Zone Safety | Tools and Power Equipment | Working Safely Around Geoprobes |
| Manual Material Handling | Excavations | Working Around Heavy Equipment | Hazardous Waste Site Controls |
| Electrical Safety | Ladders | Working Near or Over Water | Working Safely Around Drill Rigs |
| Lock Out/Tag Out | Scaffolds | Flammable and Combustible Liquids | |
| Compressed Gases | Mechanized Personnel Lifts | Hazardous Waste Site Decontamination | |

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**DESCRIPTION AND FEATURES:** *Include principal operations and unusual features (containers, buildings, dikes, power lines, hillslopes, rivers, etc.)*

An irrigation ditch runs parallel to Big Spring Creek, has steep sides, and may contain deep water.

**SURROUNDING POPULATION:** (X ) Residential ( ) Industrial ( ) Commercial ( ) Rural ( ) Urban OTHER:

**HAZARDOUS MATERIAL SUMMARY:** ***Highlight or bold waste types and estimate amounts by category.***

| **CHEMICALS:** *Amount/Units:* | **SOLIDS:** *Amount/Units:* | **SLUDGES:** *Amount/Units:* | **SOLVENTS:** *Amount/Units:* | **OILS:** *Amount/Units:* | **OTHER:** *Amount/Units:* |
|---|---|---|---|---|---|
| Acids | Flyash | Paints | Ketones | Oily Wastes | Laboratory |
| Pickling Liquors | Mill or Mine Tailings | Pigments | Aromatics | Gasoline | Pharmaceutical |
| Caustics | Asbestos | Metals Sludges | **Hydrocarbons** | **Diesel Oil** | Hospital |
| Pesticides | Ferrous Smelter | POTW Sludge | Alcohols | Lubricants | Radiological |
| Dyes or Inks | Non-Ferrous Smelter | Distillation Bottoms | Halogenated (chloro, bromo) | Polynuclear Aromatics | Municipal |
| Cyanides | Metals | Aluminum | Esters | PCBs | Construction |
| **Phenols** | **Dioxins** | | Ethers | Heating Oil | Munitions |
| Halogens | | | | | |
| Other - *specify* | Other - *specify* | Other - *specify* | Other - *specify* | Other - *specify* | Other - *specify* |

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| KNOWN CONTAMINANTS | | HIGHEST OBSERVED CONCENTRATION | PEL/TLV *ppm or mg/m3 (specify)* | IDLH *ppm or mg/m3 (specify)* | Warning Concentration *(in ppm)* | SYMPTOMS & EFFECTS OF ACUTE EXPOSURE | PHOTO IONIZATION POTENTIAL |
|---|---|---|---|---|---|---|---|
| Dioxin | soil | | 1 ug/m3 | NA | NA | Chloracne | NE |
| Pentachlorophenol | soil | 30000 ug/kg | 0.5 mg/m3 | 150 mg/m3 | NA | Eye irritation, skin and nose | NE |

**NA = Not Available** **NE = None Established** **U = Unknown**

Verify your access to an MSDS for each chemical you will use at the site.

| | | | | | |
|---|---|---|---|---|---|
| S = Soil | SW = Surface Water | T = Tailings | W = Waste | TK = Tanks | SD = Sediment |
| A = Air | GW = Ground Water | SL = Sludge | D = Drums | L = Lagoons | OFF = Off-Site |

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| SPECIFIC TASK DESCRIPTIONS | Disturbing the Waste? | TASK - SPECIFIC HAZARDS | HAZARD & SCHEDULE |
|---|---|---|---|
| 1 Field oversight of conducting soil borings, soil sampling, and a groundwater slug test. | Non-intrusive | noise, slips or falls | Spring 2007 |
| 2 | Intrusive<br>Non-intrusive | | |
| 3 | Intrusive<br>Non-intrusive | | |
| 4 | Intrusive<br>Non-intrusive | | |
| 5 | Intrusive<br>Non-intrusive | | |
| 6 | Intrusive<br>Non-intrusive | | |

**SPECIALIZED TRAINING REQUIRED:**

**SPECIAL MEDICAL SURVEILLANCE REQUIREMENTS:**

**OVERALL HAZARD EVALUATION:** ( ) High ( ) Medium (X) Low ( ) Unknov *(Where tasks have different hazards, evaluate each.)*

**JUSTIFICATION:**

**FIRE/EXPLOSION POTENTIAL:** ( ) High ( ) Medium ( X ) Low ( ) Unknown

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**CDM Health and Safety Program** **PROJECT DOCUMENT #:**

**PROTECTIVE EQUIPMENT:** *Specify by task. Indicate type and/or material, as necessary. Group tasks if possible. Use copies of this sheet if needed.*

**BLOCK A**

TASKS:
ALL LEVEL: D - Modified
(X) Primary ( ) Contingency

Respiratory: ( X ) Not needed
( ) SCBA, Airline:
( ) APR:
( ) Cartridge:
( ) Escape Mask:
( ) Other:

Head and Eye: ( ) Not needed
( X ) Safety Glasses:
( ) Face Shield:
( ) Goggles:
( X ) Hard Hat:
( ) Other:

Boots: ( ) Not needed
( X ) Steel-Toe ( ) Steel Shank
( ) Rubber ( ) Leather
( ) Overboots:

Prot. Clothing: (X ) Not needed
( ) Encapsulated Suit:
( ) Splash Suit
( ) Apron:
( ) Tyvek Coverall or
( ) Saranex Coverall
( ) Cloth Coverall:
( ) Other:

Gloves: ( ) Not needed
( ) Undergloves:
( X ) Gloves:
( ) Overgloves:

Other: specify below
( ) Tick Spray
( ) Flotation Device If Over Water
( X ) Hearing Protection
( ) Sun Screen

**BLOCK B**

TASKS: 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10
LEVEL: A - B - C - D - Modified
( ) Primary ( ) Contingency

Respiratory: ( ) Not needed
( ) SCBA, Airline:
( ) APR:
( ) Cartridge:
( ) Escape Mask:
( ) Other:

Head and Eye: ( ) Not needed
( ) Safety Glasses:
( ) Face Shield:
( ) Goggles:
( ) Hard Hat:
( ) Other:

Boots: ( ) Not needed
( ) Steel-Toe ( ) Steel Shank
( ) Rubber ( ) Leather
( ) Overboots: Latex

Prot. Clothing: ( ) Not needed
( ) Encapsulated Suit:
( ) Splash Suit
( ) Apron:
( ) Tyvek Coverall or
( ) Saranex Coverall
( ) Cloth Coverall:
( ) Other:

Gloves: ( ) Not needed
( ) Undergloves: PVC
( ) Gloves:
( ) Overgloves: Nitrile

Other: specify below
( ) Tick Spray
( ) Float. Device If Over Water
( ) Heating Protection
( ) Sun Screen

**BLOCK C**

TASKS: 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10
LEVEL: A - B - C - D - Modified
( ) Primary ( ) Contingency

Respiratory: ( ) Not needed
( ) SCBA, Airline:
( ) APR:
( ) Cartridge:
( ) Escape Mask:
( ) Other:

Head and Eye: ( ) Not needed
( ) Safety Glasses:
( ) Face Shield:
( ) Goggles:
( ) Hard Hat:
( ) Other:

Boots: ( ) Not needed
( ) Steel-Toe ( ) Steel Shank
( ) Rubber ( ) Leather
( ) Overboots:

Prot. Clothing: ( ) Not needed
( ) Encapsulated Suit:
( ) Splash Suit
( ) Apron:
( ) Tyvek Coverall
( ) Saranex Coverall
( ) Cloth Coverall:
( ) Other:

Gloves: ( ) Not needed
( ) Undergloves:
( ) Gloves:
( ) Overgloves:

Other: specify below
( ) Tick Spray
( ) Flotation Device
( ) Heating Protection
( ) Sun Screen

**BLOCK D**

TASKS: 1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10
LEVEL: A - B - C - D - Modified
( ) Primary ( ) Contingency

Respiratory: ( ) Not needed
( ) SCBA, Airline:
( ) APR:
( ) Cartridge:
( ) Escape Mask:
( ) Other:

Head and Eye: ( ) Not needed
( ) Safety Glasses:
( ) Face Shield:
( ) Goggles:
( ) Hard Hat:
( ) Other:

Boots: ( ) Not needed
( ) Steel-Toe ( ) Steel Shank
( ) Rubber ( ) Leather
( ) Overboots:

Prot. Clothing: ( ) Not needed
( ) Encapsulated Suit:
( ) Splash Suit
( ) Apron:
( ) Tyvek Coverall
( ) Saranex Coverall
( ) Cloth Coverall:
( ) Other:

Gloves: ( ) Not needed
( ) Undergloves:
( ) Gloves:
( ) Overgloves:

Other: specify below
( ) Tick Spray
( ) Flotation Device
( ) Heating Protection
( ) Sun Screen

*This health and safety plan form constitutes hazard analysis per 29 CFR 1910.132*

| HEALTH AND SAFETY PLAN FORM<br>CDM Health and Safety Program | | *This document is for the exclusive use of CDM and its subcontractors* | | **CAMP DRESSER & McKEE INC.**<br>**PROJECT DOCUMENT #:** |
|---|---|---|---|---|
| **MONITORING EQUIPMENT:** | | *Specify by task. Indicate type as necessary. Attach additional sheets if needed.* | | |
| **INSTRUMENT** | **TASK** | **ACTION GUIDELINES** | | **COMMENTS** |
| **Combustible Gas Indicator** | 1-2-3-4-5-6-7-8 | 0-10% LEL<br>10-25% LEL<br>>25% LEL<br>21.0% O2<br><21.0% O2<br><19.5% O2 | *No explosion hazard*<br>*Potential explosion hazard; notify SHSC*<br>*Explosion hazard; interrupt task/evacuate*<br>*Oxygen normal*<br>*Oxygen deficient; notify SHSC*<br>*Interrupt task/evacuate* | ( X ) Not Needed |
| **Radiation Survey Meter** | 1-2-3-4-5-6-7-8 | 3 x Background:<br>>2mR/hr: | *Notify HSM*<br>*Establish REZ* | ( X) Not Needed |
| **Photoionization Detector**<br>_____eV Lamp<br>Type_____ | Drilling activities | *Specify:*<br>bkgd to 1 ppm: Level D<br>1 to 10 ppm; Level D. Use benzene detector tubes<br>>10 ppm: Exit Area. Call health & Safety | | ( ) Not Needed |
| **Flame Ionization Detector**<br>Type_____ | 1-2-3-4-5-6-7-8 | | | (X ) Not Needed |
| **Single Gas**<br>Type_____<br>Type_____ | 1-2-3-4-5-6-7-8 | *Specify:* | | ( X ) Not Needed |
| **Respirable Dust Monitor**<br>Type_____<br>Type_____ | 1-2-3-4-5-6-7-8 | *Specify:* | | ( X ) Not Needed |
| **Other**<br>*Specify:*<br>Type_____<br>Type_____ | 1-2-3-4-5-6-7-8 | *Specify:* | | ( X ) Not Needed |
| **Other**<br>*Specify:*<br>Type_____<br>Type_____ | 1-2-3-4-5-6-7-8 | *Specify:* | | ( X ) Not Needed |

| HEALTH AND SAFETY PLAN FORM<br>CDM Health and Safety Program | *This document is for the exclusive use of CDM and its subcontractors* | CAMP DRESSER & McKEE INC.<br>PROJECT DOCUMENT #: |
|---|---|---|
| **DECONTAMINATION PROCEDURES** | | |
| **ATTACH SITE MAP INDICATING EXCLUSION, DECONTAMINATION, & SUPPORT ZONES AS PAGE TWO** | | |
| **Personnel Decontamination**<br>*Summarize below or attach diagram;*<br>Refer to SAP<br>( ) Not Needed | **Sampling Equipment Decontamination**<br>*Summarize below or attach diagram;*<br>Refer to SAP<br>( ) Not Needed | **Heavy Equipment Decontamination**<br>*Summarize below or attach diagram;*<br>Refer to SAP<br>( ) Not Needed |
| **Containment and Disposal Method**<br>Refer to SAP | **Containment and Disposal Method**<br>Refer to SAP | **Containment and Disposal Method**<br>Refer to SAP |

**HAZARDOUS MATERIALS TO BE BROUGHT ONSITE**

| *Preservatives* | | *Decontamination* | | *Calibration* | |
|---|---|---|---|---|---|
| ( ) Hydrochloric Acid | ( ) Zinc Acetate | ( ) Alconox ™ | ( ) Hexane | ( ) 100 ppm isobutylene | ( ) Hydrogen Sulfide |
| ( ) Nitric Acid | ( ) Ascorbic Acid | ( ) Liquinox ™ | ( ) Isopropanol | ( ) Methane | ( ) Carbon Monoxide |
| ( ) Sulfuric Acid | ( ) Acetic Acid | ( ) Acetone | ( ) Nitric Acid | ( ) Pentane | ( ) pH Standards |
| ( ) Sodium Hydroxide | ( ) Other: | ( ) Methanol | ( ) Other: | ( ) Hyrogen | ( ) Conductivity Std |
| | | ( ) Mineral Spirits | | ( ) Propane | ( ) Other: |

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**CDM Health and Safety Program** **PROJECT DOCUMENT #:**

**EMERGENCY CONTACTS**

| | |
|---|---|
| Water Supply | |
| Site Telephone | |
| EPA Release Report #: | 800 / 424 - 8802 |
| CDM 24-Hour Emergency #: | 732 / 539 - 8128 |
| Facility Management | |
| Other (specify) | |
| CHEMTREC Emergency #: | 800 / 424 - 9300 |

**SAFETY NARRATIVE:** *Summarize below*

Work will be conducted during daylight hours. If conditions are very cold, warm clothing will be worn and frequent breaks will be taken in a warm vehicle. If conditions are very, warm, plenty of water will be on hand, and frequent breaks will be taken in a cool area.

| EMERGENCY CONTACT! | NAME | PHONE |
|---|---|---|
| Health and Safety Manager | Jim Skrabak | 617 / 452 - 6069 |
| Project Manager | Gwen Pozega | 406-441-1406 |
| Site Safety Coordinator | Curt Coover | 406-441-1427 |
| Client Contact | Laura Alvey | 406-841-5062 |
| Other *(specify)* | | |
| Environmental Agency | | |
| State Spill Number | Montana | (800) 472 - 2121 |
| Fire Department | | 911 |
| Police Department | | 911 |
| State Police | | 911 |
| Health Department | | |
| Poison Control Center | Nationwide | 800 / 222 - 1222 |
| Occupational Physician | Kenneth Chase | 800 / 777 - WOHA |

| MEDICAL EMERGENCY | | PHONE |
|---|---|---|
| Hospital Name: | Central Montana | 538-7711 |
| Hospital Address | 408 Wendell Ave. | |
| Name of Contact at Hospital: | | |
| Name of 24-Hour Ambulance: | | |
| Route to Hospital: | | |

Start at Cheadle Street, Turn Right on Joyland Road-go 0.6 miles, Bear Right on 4th Street-go 0.1 miles, Continue on 4th Street West-go 0.1 miles, continue on 4th Street- go 0.2 miles

Distance to Hospital 1.9 miles

**HEALTH AND SAFETY PLAN APPROVALS (H&S Mgr must sign each plan)**

| | | | |
|---|---|---|---|
| Prepared by | Gwen Pozega | Date | Feb 07, 2007 |
| DHSC Signature | | Date | |
| HSM Signature | | Date | Feb 07, 2007 |

# HEALTH AND SAFETY PLAN SIGNATURE FORM

**CDM Health and Safety Plan**

All site personnel must sign this form indicating receipt of the H&SP. Keep this original on site. It becomes part of the permanent project files. Send a copy to the Health and Safety Manager (HSM).

**SITE NAME/NUMBER:** Berg Lumber Mill

**DIVISION/LOCATION:** West/Helena

**CERTIFICATION:**

I understand, and agree to comply with, the provisions of the above referenced H&SP for work activities on this project. I agree to report any injuries, illnesses or exposure incidents to the site Health and Safety Coordinator (SHSC). I agree to inform the SHSC about any drugs (legal and illegal) that I take within three days of site work.

| PRINTED NAME | SIGNATURE | DATE |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

# Appendix B
# Standard Operating Procedures

# Sample Custody

Prepared: David O. Johnson

Technical Review: Shelley Thibeault

QA Review: Laura Splichal

Approved: Michael C. Malloy 2/24/04
Signature/Date

Issued: 2/18/04
Signature/Date

## 1.0 Objective

Due to the evidentiary nature of samples collected during environmental investigations, possession must be traceable from the time the samples are collected until their derived data are introduced as evidence in legal proceedings. To maintain and document sample possession, sample custody procedures are followed. All paperwork associated with the sample custody procedures will be retained in CDM Federal Programs Corporation (CDM) files unless the client requests that it be transferred to them for use in legal proceedings or at the completion of the contract.

**Note**: Sample custody documentation requirements vary with the specific EPA region or client. This SOP is intended to present basic sample custody requirements, along with common options. Specific sample custody requirements should be presented in the project-specific quality assurance (QA) project plan or project-specific modification or clarification form (see Section U-1).

## 2.0 Background

### 2.1 Definitions

**Sample** – A sample is material to be analyzed that is contained in single or multiple containers representing a unique sample identification number.

**Sample Custody** – A sample is under custody if:

1. It is in your possession
2. It is in your view, after being in your possession
3. It was in your possession and you locked it up
4. It is in a designated secure area

**Chain-of-Custody Record** – A chain-of-custody record is a form used to document the transfer of custody of samples from one individual to another.

**Custody Seal** – A custody seal is a tape-like seal that is part of the chain-of-custody process and is used to detect tampering with samples after they have been packed for shipping.

**Sample Label** – A sample label is an adhesive label placed on sample containers to designate a sample identification number and other sampling information.

**Sample Tag** – A sample tag is attached with string to a sample container to designate a sample identification number and other sampling information. Tags may be used when it is difficult to physically place adhesive labels on the container (e.g., in the case of small air sampling tubes).

## 3.0 Responsibilities

**Sampler** – The sampler is personally responsible for the care and custody of the samples collected until they are properly transferred or dispatched.

**Field Team Leader** – The field team leader (FTL) is responsible for ensuring that strict chain-of-custody procedures are maintained during all sampling events. The FTL is also responsible for coordinating with the subcontractor laboratory to ensure that adequate information is recorded on custody records. The FTL determines whether proper custody procedures were followed during the fieldwork and decides if additional samples are required.

**Field Sample Custodian** – The field sample custodian, when designated by the FTL, is responsible for accepting custody of samples from the sampler(s) and properly packing and shipping the samples to the laboratory assigned to do the analyses. A field sample custodian is typically designated only for large and complex field efforts.

## 4.0 Required Supplies

- Chain-of-custody records (applicable client or CDM forms)
- Sample labels or tags
- Custody seals
- Clear tape

## 5.0 Procedures

### 5.1 Chain-of-Custody Record

This procedure establishes a method for maintaining custody of samples through use of a chain-of-custody record. This procedure will be followed for all samples collected or split samples accepted.

**Field Custody**

1. Collect only the number of samples needed to represent the media being sampled. To the extent possible, determine the quantity and types of samples and sample locations prior to the actual fieldwork. As few people as possible should handle samples.

2. Complete sample labels or tags for each sample using waterproof ink.

3. Maintain personal custody of the samples (in your possession) at all times until custody is transferred for sample shipment or directly to the analytical laboratory.

**Transfer of Custody and Shipment**

1. Complete a chain-of-custody record for all samples (see Figure 1 for an example of a chain-of-custody record. Similar forms may be used when requested by the client). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents sample custody transfer from the sampler, often through another person, to the sample custodian in the appropriate laboratory.

   - The date/time will be the same for both signatures when custody is transferred directly to another person. When samples are shipped via common carrier (e.g., Federal Express), the date/time will not be the same for both signatures. Common carriers are not required to sign the chain-of-custody record.

- In all cases, it must be readily apparent that the person who received custody is the same person who relinquished custody to the next custodian.

- If samples are left unattended or a person refuses to sign, this must be documented and explained on the chain-of-custody record.

**Note**: If a field sample custodian has been designated, he/she may initiate the chain-of-custody record, sign, and date as the relinquisher. The individual sampler(s) must sign in the appropriate block, but does (do) not need to sign and date as a relinquisher (refer to Figure 1).

2. Package samples properly for shipment and dispatch to the appropriate laboratory for analysis. Each shipment must be accompanied by a separate chain-of-custody record. If a shipment consists of multiple coolers, samples in the coolers may be recorded on a single chain-of-custody record.

3. The original record will accompany the shipment, and the copies will be retained by the FTL and, if applicable, distributed to the appropriate sample coordinators. Freight bills will also be retained by the FTL as part of the permanent documentation. The shipping number from the freight bill shall be recorded on the applicable chain-of-custody record.

**Procedure for Completing CDM Example Chain-of-Custody Record**
The following procedure is to be used to fill out the CDM chain-of-custody record. The record provided herein (Figure 1) is an example chain-of-custody record. If another type of custody record (i.e., provided by the EPA contract laboratory program or a subcontract laboratory) is used to track the custody of samples, the custody record should be filled out in its entirety.

1. Record project number.
2. Record FTL for the project (if a field sample custodian has been designated, also record this name in the "Remarks" box).
3. Record the name and address of the laboratory to which samples are being shipped.
4. Enter the project name/location or code number.
5. Record overnight courier's airbill number.
6. Record sample location number.
7. Record sample number.
8. Note preservatives added to the sample.
9. Note media type (matrix) of the sample.
10. Note sample type (grab or composite).
11. Enter date of sample collection.
12. Enter time of sample collection in military time.

## Figure 1
## Example CDM Chain-of-Custody Record

**CDM**

125 Maiden Lane, 5th Floor
New York, NY 10038
(212) 785-9123
Fax: (212) 785-6114

**CHAIN OF CUSTODY RECORD**

| PROJECT ID. | FIELD TEAM LEADER | LABORATORY AND ADDRESS | DATE SHIPPED |
|---|---|---|---|
| PROJECT NAME/LOCATION | | LAB CONTRACT: | AIRBILL NO. |

MEDIA TYPE
1. Surface Water
2. Groundwater
3. Leachate
4. Field QC
5. Soil/Sediment
6. Oil
7. Waste
8. Other ______________

PRESERVATIVES
1. HCl, pH <2
2. HNO3, pH <2
3. NaOH, pH >12
4. H2SO4, pH <2
5. Zinc Acetate, pH >9
6. Ice Only
7. Not Preserved
8. Other ________________

SAMPLE TYPE
G = Grab
C = Composite

ANALYSES (List no. of containers submitted)

| SAMPLE LOCATION NO. | LABORATORY SAMPLE NUMBER | PRESER-VATIVES ADDED | MEDIA TYPE | SAMPLE TYPE | 20_ _ DATE | TIME SAMPLED | | | | | | | | | REMARKS (Note if MS/MSD) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | | | | | | | | | | | | | | | |
| 2. | | | | | | | | | | | | | | | |
| 3. | | | | | | | | | | | | | | | |
| 4. | | | | | | | | | | | | | | | |
| 5. | | | | | | | | | | | | | | | |
| 6. | | | | | | | | | | | | | | | |
| 7. | | | | | | | | | | | | | | | |
| 8. | | | | | | | | | | | | | | | |
| 9. | | | | | | | | | | | | | | | |
| 10. | | | | | | | | | | | | | | | |

SAMPLER SIGNATURES:

| RELINQUISHED BY: | DATE/TIME | RECEIVED BY: | DATE/TIME | RELINQUISHED BY: | DATE/TIME | RECEIVED BY: | DATE/TIME |
|---|---|---|---|---|---|---|---|
| (PRINT) | | (PRINT) | | (PRINT) | | (PRINT) | |
| (SIGN) | | (SIGN) | | (SIGN) | | (SIGN) | |
| RELINQUISHED BY: | DATE/TIME | RECEIVED BY: | DATE/TIME | RELINQUISHED BY: | DATE/TIME | RECEIVED BY: | DATE/TIME |
| (PRINT) | | (PRINT) | | (PRINT) | | (PRINT) | |
| (SIGN) | | (SIGN) | | (SIGN) | | (SIGN) | |

COMMENTS:

DISTRIBUTION: White and yellow copies accompany sample shipment to laboratory; yellow copy retained by laboratory. Pink copy retained by samplers.

1/98

**Note**: If requested by the client, different chain-of-custody records may be used. Copies of the template for this record may be obtained from the Chantilly Graphics Department.

13. When required by the client, enter the names or initials of the samplers next to the sample location number of the sample they collected.
14. List parameters for analysis and the number of containers submitted for each analysis.
15. Enter matrix spike/matrix spike duplicate (MS/MSD) if sample is for **laboratory** quality control or other remarks (e.g., sample depth).
16. Sign the chain-of-custody record(s) in the space provided. All samplers must sign each record.
17. If sample tags are used, record the sample tag number in the "Remarks" column.
18. The originator checks information entered in Items 1 through 16 and then signs the top left "Relinquished by" box, prints his/her name, and enters the current date and time (military).
19. Send the top two copies (usually white and yellow) with the samples to the laboratory; retain the third copy (usually pink) for the project files. Retain additional copies for the project file or distribute as required to the appropriate sample coordinators.
20. The laboratory sample custodian receiving the sample shipment checks the sample label information against the chain-of-custody record. Sample condition is checked and anything unusual is noted under "Remarks" on the chain-of-custody record. The laboratory custodian receiving custody signs in the adjacent "Received by" box and keeps the copy. The white copy is returned to CDM.

### 5.2 Sample Labels and Tags

Unless the client directs otherwise, sample labels or tags will be used for all samples collected or accepted for CDM projects.

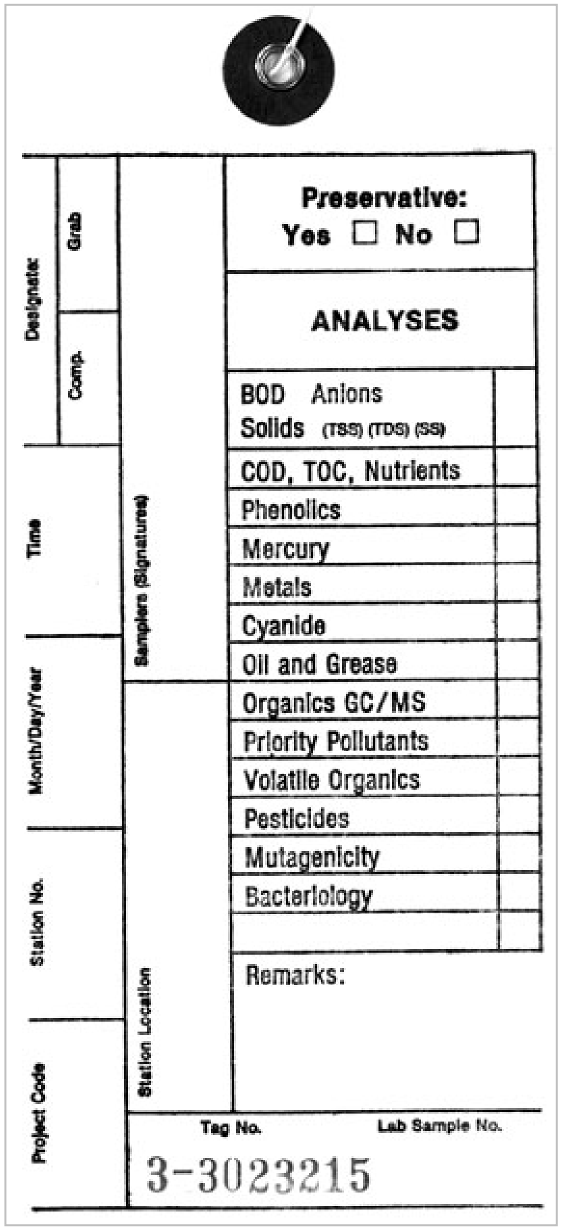
1. Complete one label or tag with the information required by the client for each sample container collected. A typical label or tag would be completed as follows (see Figure 2 for example of sample tag; labels are completed with the equivalent information):

   - Record the project code (i.e., project or task number).
   - Enter the station number (sample number) if applicable.
   - Record the date to indicate the month, day, and year of sample collection.
   - Enter the time (military) of sample collection.
   - Place a check to indicate composite or grab sample.
   - Record the station (sample) location.
   - Sign in the space provided.
   - Place a check next to "yes" or "no" to indicate if a preservative was added.
   - Place a check under "Analyses" next to the parameters for which the sample is to be analyzed. If the desired analysis is not listed, write it in the empty slot. **Note**: Do not write in the box for "laboratory sample number."
   - Place or write additional relevant information under "Remarks."

2. Place adhesive labels directly on the sample containers. Place clear tape over the label to protect from moisture.

3. Securely attach sample tags to the sample bottle. On 2.27 liter (80 oz.) amber bottles, the tag string may be looped through the ring style handle and tied. On all other containers, it is

**Figure 2**
**Example Sample Tag**




**Note**: Equivalent sample labels or tags may be used.

recommended that the string be looped around the neck of the bottle, then twisted and re-looped around the neck until the slack in the string is removed.

4. Double-check that the information recorded on the sample tag is consistent with the information recorded on the chain-of-custody record.

### 5.3 Custody Seals

Two custody seals must be placed on opposite corners of all shipping containers (e.g., cooler) prior to shipment. The seals should be signed and dated by the shipper.

Custody seals may also be placed on individual sample bottles. Check with the client or refer to EPA regional guidelines for direction.

### 5.4 Sample Shipping

The CDM standard operating procedure listed below defines the requirements for packaging and shipping environmental samples.

- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples

## 6.0 Restrictions/Limitations

Check with the EPA region or client for specific guidelines. If no specific guidelines are identified, this procedure should be followed.

For EPA Contract Laboratory Program (CLP) sampling events, combined chain-of-custody/traffic report forms or other EPA-specific records may be used. Refer to regional guidelines for completing these forms.

The EPA FORMS II Lite™ software may be used to customize sample labels and custody records when directed by the client or the CDM project manager.

## 7.0 References

U.S. Environmental Protection Agency, *EPA Guidance for Quality Assurance Project Plans*, EPA QA/G-5, EPA/600/R-98/018, February 1998, Section B3.

U.S. Environmental Protection Agency, *National Enforcement Investigations Center, Multi-Media Investigation Manual*, EPA-330/9-89-003-R, Revised March 1992, p.85.

U.S. Environmental Protection Agency, *Contract Laboratory Program (CLP), Guidance for Field Samplers*, EPA-540-R-00-003, Draft Final, June 2001, Section 3.2.

U.S. Environmental Protection Agency, *FORMS II Lite™ User's Guide*, March 2001.

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996, Section 3.3.

U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plan*, EM 200-1-3, February 2001, Appendix F.

# Surface Soil Sampling



Prepared: Del R. Baird

Technical Review: Regina Clifford

QA Review: David O. Johnson

Approved: Signature/Date

Issued: 2/18/04 Signature/Date

## 1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting surface soil samples.

## 2.0 Background

Surface soils are generally defined as the soils extending from ground surface to approximately 30 centimeters (cm) (1 foot) below ground surface (bgs). Surface soil samples are frequently collected from 0 to 15 cm (0 to 6 inches) bgs. The techniques and protocols described herein may be used to collect other surface media, including sediment and sludge.

### 2.1 Definitions

**Surface Soil** - The soil that exists down from the surface approximately 30 cm (1 foot). Depending on application, the soil interval to be sampled will vary.

**Grab Sample** - A discrete portion or aliquot taken from a specific location at a given point in time.

**Composite** - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, then a single average sample is taken from the mixture.

**Spoon/Scoop** - A small stainless steel or Teflon® utensil approximately 15 cm (6 inches) in length with a stem-like handle.

**Trowel** - A small stainless steel or Teflon shovel approximately 15 to 20 cm (6 to 8 inches) in length with a slight (approximately 140°) curve across the length. The trowel has a stem-like handle (for hand operation). Samples are collected with a spooning action.

### 2.2 Discussion

Surface soil samples are collected to determine the type(s) and level(s) of contamination and are often important to risk assessment. These samples may be collected as part of an investigative plan, site-specific sampling plan, and/or as a screen for "hot spots," which may require more extensive sampling.

Sediment(s) and sludge(s) that have been exposed by evaporation, stream rerouting, or any other means are collected by the same methods as those for surface soil(s). Typically the top 1 to 2 cm of material, including vegetation, are carefully removed before collection of the sample.

Surface soil and exposed sediment or sludge are collected using stainless steel and/or Teflon-lined trowels or scoops.

### 2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-5, Field Equipment Decontamination at Non-Radioactive Sites

## 3.0 Responsibilities

**Site Manager** - The site manager is responsible for ensuring that sampling efforts are conducted in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of surface soil samples collected meet the requirements of the site-specific plans.

**Field Team Leader** - The field team leader is responsible for ensuring that field personnel collect surface soil samples in accordance with this procedure and other relevant procedures.

## 4.0 Required Equipment

- Insulated cooler and clear waterproof sealing tape
- Ice bags or “blue ice”
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon-lined spatulas and pans, trays, or bowls
- Stainless steel and/or Teflon-lined trowels or spoons (or equipment as specified in the site-specific plans)
- Plastic sheeting
- Project plans (work plan/health and safety plan)
- Appropriate sample containers
- Field logbook
- Indelible black ink pen and/or marker
- Sample chain-of-custody forms
- Custody seals
- Decontamination supplies

Additional equipment is discussed in Section 5.2.2, VOC Field Sampling/Preservation Methods.

## 5.0 Procedures

### 5.1 Preparation

The following steps must be followed when preparing for sample collection:

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.

3. Processes for verifying depth of sampling must be specified in the site-specific plans.

4. Place clean plastic sheeting on a flat, level surface near the sampling area, if possible, and place equipment to be used on the plastic; place the insulated cooler(s) on separate plastic sheeting.

5. A clean, decontaminated trowel, scoop, or spoon will be used for each sample collected. Other equipment may be used (e.g., shovels) if constructed of stainless steel.

## 5.2 Collection

The following general steps must be followed when collecting surface soil samples:

1. Surface soil samples are normally collected from the least contaminated to the most contaminated areas, if known.

2. Document the sampling events, recording the information in the designated field logbook. Document any and all deviations from SOPs in the field logbook and include rationale for changes. See CDM Federal SOP 4-1.

3. Carefully remove stones, vegetation, snow, etc. from the ground surface in the immediate vicinity of the sampling location.

4. First collect required sample aliquot for volatile analyses as well as any other samples that would be degraded by aeration. Follow with collection of samples for other analyses.

5. Decontaminate sampling equipment between sample locations. See CDM Federal SOP 4-5.

### 5.2.1 Method for Collecting Samples for Volatile Organic Compound (VOC) Analysis

The requirements for collecting grab samples of surface soil for VOCs or other samples degraded by aeration are as follows:

1. VOC samples shall be collected with the least disturbance possible.

2. VOC samples shall be collected as grab samples; however, the method of collection will vary from site to site, based on data quality objectives and the degree of known or suspected contamination.

3. Complete sample label by filling in the appropriate information and securing the label to the container. Cover the sample label with a piece of clear tape.

4. Use a clean stainless steel or Teflon-lined trowel or spoon (or tube) to collect sufficient material in one grab to fill the sample containers.

5. With the aid of a clean stainless steel spatula, quickly fill the sample containers directly from the sampling device, removing stones, twigs, grass, etc., from the sample. Fill the containers as full and compact as possible to minimize headspace.

6. Immediately secure the Teflon-lined cap(s) on the sample container(s).

7. Wipe the containers with a clean Kimwipe or paper towel to remove any residual soil from the exterior of the container.

8. Place the containers in individual zip-top plastic bag(s) and seal the bag(s).

9. Pack all samples as required. Include properly completed documentation and affix signed and dated custody seals to the cooler lid.

**Note:** A trip blank should be included with sample coolers containing VOC samples. QC sample requirements vary from project to project. Consult the project-specific work plan for requirements.

**5.2.2 VOC Field Sampling/Preservation Methods**
The following four sections contain SW-846 test methods for sampling and field preservation. These methods include EN CORE™ Sampler Method for low-level analyses, EN CORE Sampler Method for high-level analyses, acid preservation for low-level analyses, and methanol preservation for high-level analyses. These methods are very detailed and contain equipment requirements at the beginning of each section.

When collecting soil samples using the EN CORE Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust "wet" concentration results to "dry" concentrations to meet analytical method requirements.

**Note:** Some variations from these methods (e.g., sample volume) may be required depending on the contracted analytical laboratory.

*5.2.2.1 EN CORE Sampler Collection for Low Level Analyses (≥1 μg/kg)*
**EN CORE Sampling Equipment Requirements**
The following equipment is required for low-level analysis:

- Three 5-gram (g) samplers

**Note:** The sample volume requirements are general requirements. Actual sample volumes, sizes, and quantities may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce) widemouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

**EN CORE Sampling Steps for Low Level Analysis**

1. Remove sampler and cap from package and attach T-handle to sampler body.

2. Quickly push the sampler into a freshly exposed surface of soil until the O-ring is visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

3. Extract the sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.

4. Push cap on with a twisting motion to secure to the sampler body.

5. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.

6. Fill out sample label and attach to sampler.

7. Repeat procedure for the remaining two samplers.

8. Collect moisture sample in 110-mL (4-ounce) widemouth jar using a clean stainless steel spoon or trowel.

9. Store samplers at 4° Celsius (C), ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

**Note:** Verify requirements for extraction/holding times.

*5.2.2.2 Acid Preservation Sampling for Low Level Analyses (≥1 μg/kg)*
**Note:** Determine specific field acid preservation procedure based on the requirements specified in the analytical method to be employed. Variations between analytical methods exist with respect to field acid preservation.

**Acid Preservation Sampling Equipment Requirements**
The following equipment and supplies are required if field acid preservation is required:

- One 40 mL VOA vial with acid preservation (for field testing of soil pH)
- Two pre-weighed 40 mL VOA vials with acid preservative and stir bar (for lab analysis)
- Two pre-weighed 40 mL VOA vials with water and stir bar (in case samples cannot be pre-preserved)
- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (for screening sample and/or high level analysis)
- One 110-mL (4-oz) widemouth glass jar or applicable container for moisture analysis
- One 55-mL (2-oz) jar with acid preservative (in case additional acid is needed due to high soil pH)
- One appropriately sized scoop capable of delivering 1 g of solid sodium bisulfate
- pH paper
- Weighing scale capable of reading to 0.01 g
- Set of balance weights used in daily balance calibration
- Gloves for working with pre-weighed sample vials
- Paper towels
- Sodium bisulfate acid solution ($NaHS0_4$)
- A cutoff plastic syringe or other coring device capable of collecting sufficient sample volume (5 g)

**Testing Effervescing Capacity of Soils**
Soils must be tested with acid to determine the amount of effervescing that will occur when preserved with acid. Effervescing will drive off VOCs as well as create a high pressure in a sealed vial that could result in the explosion of the sample container. The following steps provide information on the effervescing capacity of the soil.

1. Place approximately 5 g of soil into a vial that contains acid preservative and no stir bar.

2. Do not cap this vial as it may EXPLODE upon interaction with the soil.

3. Observe the sample for gas formation (due to carbonates in the soil).

4. If vigorous or sustained gas emissions are observed, then acid preservation is not acceptable to preserve the sample.

   - In this case the samples need to be collected in the VOA vials with only water and a stir bar. The vials with acid preservative CANNOT be used.

5. If a small amount or no gas formation occurs, then acid preservation is acceptable to preserve the sample. Keep this testing vial for use in the buffering test detailed below.

   - In this case the samples need to be collected in the VOA vials with the acid preservative and a stir bar.

**Testing Buffering Capacity of Soils**
The soils must be tested to determine the quantity of acid that is required to achieve a pH reading of ≤2 standard units (STUs). The following steps will assist in determining this quantity.

1. If acid preservation is acceptable for sampling soils, then the sample vial that was used to test the effervescing capacity of the soils can be used to test the buffering capacity.

2. Cap the vial that contains 5 g of soil, acid preservative, and no stir bar from Step 1 in the effervescing test.

3. Shake the vial gently to homogenize the contents.

4. Open the vial and check the pH of the acid solution with pH paper.

   - If the pH paper reads below 2, then the sampling can be done in the two pre-weighed 40 mL VOA vials with the acid preservative and stir bar. Since the pH was below 2, it is not necessary to add additional acid to the vials.

   - If the pH paper reads above 2, then additional acid needs to be added to the sample vial.

5. Use the jar with the solid sodium bisulfate acid and add another 1 g of acid to the sample.

6. Cap the vial and shake thoroughly again.

7. Repeat Step 4.

    - If the pH paper reads below 2, then the sampling can be done in the two pre-weighed 40 mL VOA vials with the acid preservative and stir bar and 1 g extra of acid.

    - Make a note of the extra gram of acid needed so the same amount of acid can be added to the vials the lab will analyze.

    - If the pH paper reads above 2, repeat Steps 5 through 7 until the sample pH ≤2 STUs.

Now that the soil chemistry has been determined, the actual sampling can occur. The procedure stated below assumes the correct vials are used based on the guidance discussed.

**Sample Preservation Steps**

1. Wear gloves during all handling of pre-weighed vials.

2. Add more acid if necessary (based on the buffering capacity testing discussed in the previous section).

3. Quickly collect a 5-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g of soil from a freshly exposed surface of soil.

4. Carefully wipe exterior of sample collection device with a clean paper towel.

5. Quickly transfer the sample to the appropriate VOA vial, using caution when extruding the sample to prevent splashing of the acid in the vial.

6. Remove any soil from the threads of the sample vial using a clean paper towel.

7. Cap vial and weigh the jar to the nearest 0.01 g.

8. Record exact weight on sample label.

9. Repeat sampling procedure for the duplicate VOA vial.

10. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation below.

11. Take the empty jar or the jar that contains the methanol preservative.

12. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size is dependent on who is doing the sampling and requirements specified by the client or analytical laboratory.

13. Carefully wipe the exterior of the collection device with a clean paper towel.
14. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial.
15. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.
16. Remove any soil from the threads of the sample vial using a clean paper towel and cap the jar.
17. Weigh the jar with sample to the nearest 0.01 g and record the weight on the sample label.
18. Collect dry weight sample using a clean stainless steel spoon or trowel.
19. Store samples at 4°C, ±2°C.
20. Ship sample containers to the analytical laboratory with plenty of ice and in accordance with Department of Transportation (DOT) regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

*5.2.2.3 EN CORE Sampler Collection for High Level Analyses (≥200 µg/kg)*
**EN CORE Sampling Equipment Requirements**
The following equipment is required for high-level analysis.

- One 5-g sampler or one 25-g sampler

**Note:** The volume requirements specified are general requirements. Actual sample volumes, container sizes, and quantities may vary depending on client or laboratory requirements.

- One 110-mL (4-oz) widemouth glass jar or applicable container specified for moisture analysis
- One T-handle
- Paper towels

**EN CORE Sampling Steps for High Level Analysis**

1. Remove sample and cap from package and attach T-handle to sampler body.
2. Quickly push the sampler into freshly exposed surface of soil until the O-ring is visible within the hole/window on the side of the T-handle. If the O-ring is not visible within the window/hole, then the sampler is not full.
3. Use a clean paper towel to quickly wipe the sampler head so that the cap can be tightly attached.
4. Push cap on with a twisting motion to secure to the sampler body.
5. Fill out sample label and attach to sampler.

6. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.

7. Collect moisture sample in 110-mL (4-oz) widemouth glass jar or designated container using a clean stainless steel spoon or trowel.

8. Store samplers at 4°C, ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

**Note:** Verify requirements for extraction/holding times.

***5.2.2.4 Methanol Preservation Sampling for High Level Analyses (≥200 µg/kg)***
**Methanol Preservation Sampling Equipment Requirements**

- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (laboratory grade)
- One dry weight cup
- Weighing balance that accurately weighs to 0.01 g
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil

**Sampling Preservation Steps**

1. Wear gloves during all handling of pre-weighed vials.

2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.

3. Take the empty jar or the jar that contains the methanol preservative.

4. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil.

5. Carefully wipe the exterior of the collection device with a clean paper towel.

6. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.

7. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

8. Remove any soil from the exterior of the vial using a clean paper towel and cap the sample jar.

9. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.

10. Collect a dry weight sample using a clean stainless steel spoon or trowel.

11. Store samples at 4°C ±2°C.

12. Ship sample containers with plenty of ice to the analytical laboratory in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON).

**5.2.3 Method for Collecting Samples for Nonvolatile Organic or Inorganic Compound Analysis**
The requirements for collecting samples of surface soil for nonvolatile organic or inorganic analyses are as follows:

1. Label each sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

2. Use a decontaminated stainless steel or Teflon-lined trowel or spoon to obtain sufficient sample from the required interval and sub-sampling points, if necessary, to fill the specified sample containers.

3. Empty the contents of each fill of the sampling device directly into a clean stainless steel or Teflon-lined tray or bowl.

4. Homogenize the sample by mixing with a spoon, spatula, or trowel.

5. Use the spoon, spatula, or trowel to distribute the uniform mixture into the labeled sample containers. Fill organic sample containers first, then inorganics.

6. Secure the appropriate cap on each container immediately after filling it.

7. Wipe the sample containers with a clean Kimwipe or paper towel to remove any residual soil.

8. Place sample containers in individual zip-top plastic bags and seal the bags.

9. Pack all samples as required. Include properly completed documentation and affix custody seals to the cooler lid.

10. Decontaminate sampling equipment according to CDM Federal SOP 4-5.

## 6.0 Restrictions/Limitations
When grab sampling for VOC analysis or for analysis of any other compound(s) that may be degraded by aeration, it is necessary to minimize sample disturbance and, hence, analyte loss. The representativeness of this sample is difficult to determine because the collected sample represents a single point, is not homogenized, and has been disturbed.

## 7.0 References

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2, September 1996.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1, September 1996 or current revision.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987 or current revision.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste*, Physical/Chemical Methods (SW-846), Third Edition, November 1986, (as amended by Update III, June 1997). Method 5035: Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

# Subsurface Soil Sampling

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QA Review: David O. Johnson

Approved: Michael C. Malloy 2/24/04
Signature/Date

Issued: 2/18/04
Signature/Date

## 1.0 Objective

The objective of this standard operating procedure (SOP) is to define the techniques and requirements for collecting soil samples from the unconsolidated zone. Techniques include use of hand augers, Shelby tubes, continuous core samplers, and split-spoon samplers.

## 2.0 Background

### 2.1 Definitions

**Unconsolidated Zone** - The layer of soil above bedrock that exists in a relatively loose state.

**Hand Auger** - A stainless steel cylinder (bucket) approximately 7 to 10 centimeters (cm) (3 to 4 inches) in diameter and 30 cm (1 foot) in length, open at both ends with the bottom edge designed to twist into the soil and cut out a soil core. The bucket collects the soil sample. The auger has a T-shaped handle (for hand operation) attached to the top of the bucket by extendable stainless steel rod(s).

**Shelby Tube** - A cylindrical sampling device, generally made of steel, that is driven into the subsurface soil through the hollow-stem auger. The tube, once retrieved, may be capped and the undisturbed soil sample extruded in the laboratory prior to analysis.

**Split-Spoon/Split-Barrel Sampler** - A cylindrical sampling device generally made of carbon steel that fits into a hollow-stem auger. The spoon is hinged lengthwise, which allows the sample to be retrieved by opening ("splitting") the spoon.

**Slide Hammer** – A device consisting of a drive weight (hammer) and a drive weight fall guide.

**Subsurface Soil** - The soil that exists deeper than approximately 30 cm (1 foot ) from the surface but above bedrock or any other consolidated material.

**Grab Sample** - A discrete portion or aliquot taken from a specific location at a given point in time.

**Liner** - A cylindrical sampling device, generally made of brass, stainless steel, or Teflon® that is placed inside a split-spoon or hand auger bucket to collect undisturbed samples.

**Composite Sample** - Two or more sub-samples taken from a specific media and site at a specific point in time. The sub-samples are collected and mixed, and then a single average sample is taken from the mixture.

**Auger Flight** - A steel section length attached to an auger to extend the auger and remove unconsolidated material as coring depth increases.

### 2.2 Discussion

Shallow subsurface soil samples (to depths between 0.15 cm to 3 meters (m) [6 inches and 10 feet]) may be collected using hand augers. However, soil samples collected with a hand auger are commonly of poorer quality than those collected by split-spoon/split-barrel or Shelby tube samplers since the soil sample is disturbed in the augering process. Split-spoon/split-barrel and Shelby tube liners are generally used during collection of soil samples using a hollow-stem auger, but may also be used to collect undisturbed soil samples from hand auger borings using a slide-hammer device. Liners are used to minimize the loss of volatile organic compounds (VOCs). The size and construction material of sampling devices should be selected based on project and analytical objectives and defined in site-specific plans.

### 2.3 Associated Procedures

- CDM Federal SOP 1-2, Sample Custody
- CDM Federal SOP 2-1, Packaging and Shipping Environmental Samples
- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites

## 3.0 Responsibilities

**Site Manager** - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and the required equipment, and for ensuring that subsurface soil samples are collected in accordance with this procedure and any other SOPs pertaining to specific media sampling. The site manager must also ensure that the quantity and location of subsurface soil samples collected meet the requirements of the site-specific plans.

**Field Team Leader** - The field team leader is responsible for ensuring that field personnel collect subsurface soil samples in accordance with this SOP and other relevant procedures.

## 4.0 Required Equipment

### 4.1 General

- Site-specific plans
- Field logbook
- Indelible black ink pens and markers
- Labels and appropriate forms/documentation for sample shipment
- Clear, waterproof tape
- Appropriate sample containers
- Insulated cooler(s) and waterproof sealing tape
- Ice bags or “blue ice”
- Latex or appropriate gloves
- Plastic zip-top bags
- Personal protective clothing and equipment
- Stainless steel and/or Teflon-lined spatulas and pans, trays, bowls, trowels, or spoons
- Plastic sheeting
- Decontamination supplies

Additional equipment is discussed in Section 5.2.5, Field Sampling/Preservation Methods.

### 4.2 Manual (Hand) Augering

- T-handle
- Hand auger: flighted-, bucket-, or tube-type auger as required by the site-specific plans
- Extension rods
- Wrench(es), pliers
- Slide-hammer with extension rods

### 4.3 Split-Spoon/Split-Barrel and Shelby Tube Sampling

- Drill rig equipped with a 63-kilogram (kg) (140-lb) drop hammer and sufficient hollow-stem augers to drill to the depths required by the site-specific plans.
- Sufficient numbers of split-spoon/split-barrel or Shelby tube samplers so that at least one is always decontaminated and available for sampling. Three split-spoon/split-barrel or Shelby tube samplers are generally the minimum necessary. (Shelby tubes are usually used only once.)
- Split-spoon liners (as appropriate).
- Wrench(es), hammer.

## 5.0 Procedures

### 5.1 Preparation

1. Don the appropriate personal protective clothing as dictated by the site-specific health and safety plan.

2. Locate sampling location(s) in accordance with project documents (e.g., work plan) and document pertinent information in the appropriate field logbook. When possible, reference locations back to existing site features such as buildings, roads, intersections, etc.

3. Processes for verifying depth of sampling must be specified in the site-specific plans.

4. Clear away vegetation and debris from the ground surface at the boring location.

5. Prepare an area next to the sample collection location for laying out cuttings by placing plastic sheeting on the ground to cover the immediate area surrounding the borehole.

6. Set up a decontamination line, if decontamination is required, in accordance with CDM Federal SOP 4-5.

### 5.2 Collection

The following general steps must be followed when collecting all subsurface soil samples:

1. VOC samples or samples that may be degraded by aeration shall be collected first and with the least disturbance possible.

2. Sampling information shall be recorded in the field logbook and on any associated forms. Describe lithology, according to CDM Federal SOP 3-5, in the field logbook or on the lithologic log form.

3. Specific sampling devices to be used shall be identified in the site-specific plans and recorded in the field logbook.

4. Care must be taken to prevent cross-contamination and misidentification of samples.

5. Sample containers containing samples for VOC analysis should be filled completely to minimize headspace.

**5.2.1 Manual (Hand) Augering**

The following steps must be followed when collecting hand-augered samples:

1. Auger to the depth required for sampling. Place cuttings on plastic sheeting or as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout the augering, make detailed notes concerning the geologic features of the soil or sediments in the field logbook.

3. Cease augering when the top of the specified sampling depth has been reached. If required, remove the auger from the hole and decontaminate the auger or use a separate decontaminated auger, then obtain the sample.

4. Collect a grab sample for VOC analyses (or samples that may be degraded by aeration) immediately and place in sample container. Sample bottles should be filled completely to minimize headspace.

5. Remaining sample should be homogenized for other analyses prior to placing samples in the appropriate containers. Label containers as required.

6. Wipe containers with a clean Kimwipe or paper towel to remove residual soil from the exterior of the container(s).

7. Label the sample container with the appropriate information. Secure the label by covering it with a piece of clear tape.

8. Place the containers in zip-top plastic bags and seal the bags. Pack samples in a cooler with ice.

9. Proceed with further sampling, as required by the site-specific plans.

10. When all sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Complete the field logbook entry and other appropriate forms, being sure to record all relevant information before leaving the site.

12. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal

SOPs 1-2 and 2-1 or site-specific plans.

#### 5.2.2 Manual (Hand) Augering Using a Tube Sampler with Liner or Slide-Hammer

The following steps must be followed when collecting hand-augered samples using a tube sampler with liner or slide-hammer:

1. Auger to the depth required for sampling. Place cuttings on the plastic sheeting as specified in the site-specific plans. If possible, lay out the cuttings in stratigraphic order.

2. Throughout augering, make detailed notes in the field logbook concerning the geologic features of the soil or sediments.

3. Cease augering when the top of the specified sampling depth has been reached. Remove the auger from the hole and decontaminate.

4. Prepare a decontaminated tube sampler by installing a decontaminated liner in the auger tube.

5. Obtain the sample by driving the sample tube through the sample interval with the slide-hammer. Remove the liner from the tube and immediately cover the ends with Teflon tape and cap the ends of the tube. Seal the caps with waterproof tape.

6. Wipe sealed liners with a clean Kimwipe or paper towel.

7. Label the sealed liners as required in the site-specific plans. Mark the top and bottom of the sample on the outside of the liner.

8. Place sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

9. Proceed with further sampling, as required by the site-specific plans.

10. When sampling is complete, dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.

11. Decontaminate all equipment according to CDM Federal SOP 4-5 between each sample.

12. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

13. Properly package all samples for shipment and complete all necessary sample shipment documentation. Remand custody of samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

#### 5.2.3 Split-Spoon/Split Barrel Sampling

**Note:** Steps 1 through 12 describe activities to be performed by a licensed drilling contractor, not CDM personnel.

The following steps must be followed when collecting split-spoon samples:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.
2. The drilling rig will be decontaminated at a separate location prior to drilling, per CDM Federal SOP 4-5 or the site-specific decontamination procedures.
3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s) to the drill rig.
4. Begin drilling and proceed to the first designated sample depth, adding auger(s) as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods.
7. If required by the site-specific sampling plan, install decontaminated liners in the split-spoon/split barrel sampler.
8. Install a decontaminated split-spoon on the center rod(s) and insert it into the hollow-stem auger. Connect the hammer assembly and lightly tap the rods to seat the drive shoe at the top of undisturbed soil or sediment.
9. Mark the center rod in 15-cm (6-inch) increments from the top of the auger(s).
10. Drive the split-spoon using the hammer. Use a full 76-cm (30-inch) drop as specified by the American Society for Testing and Materials (ASTM) Method D-1586. Record the number of blows required to drive the spoon or tube through each 15-cm (6-inch) increment.
11. Cease driving when the full length of the spoon has been driven or upon refusal. Refusal occurs when little or no progress is made for 50 blows of the hammer. ASTM D1586-99 § 7.2.1 and 7.2.2 defines "refusal" as >50 blows per 6-inch advance or a total of 100 blows.
12. Pull the split-spoon free by using upswings of the hammer to loosen the sampler. Pull out the center rod and split-spoon.
13. Unscrew the split-spoon assembly from the center rod and place it on the plastic sheeting.
14. Remove the drive shoe and head assembly. If necessary, tap the split-spoon assembly with a hammer to loosen threaded couplings.
15. With the drive shoe and head assembly off, open (split) the split-spoon, being careful not to disturb the sample.
16. Label sample containers with appropriate information. Secure the label, covering it with a piece of clear tape. If liners were used, immediately install Teflon tape over the ends of the liners, cap the liners, and seal the caps over the ends of the liner with waterproof tape. Label the samples

as required by the site-specific plans. Mark the top and bottom of each sample on the outside of each liner. Indicate boring/well number and depth on the outside of the liner, as required.

17. If VOC analyses are to be conducted on the soil sample and liners were not used, place that sample in its sample container immediately after opening the split-spoon, filling the sample bottle completely. Seal the container immediately, then describe it in the field logbook and/or associated forms. Record the sample identification number, depth from which the sample was taken, and the analyses to be performed on the samples in the field logbook and on the appropriate forms.

18. Remaining sample should be homogenized prior to placing samples in appropriate containers.

19. Wipe containers with a clean Kimwipe or paper towel. Label containers as required when liners are not used.

20. Place containers and/or sealed liners in zip-top plastic bags and seal the bags. Pack samples in a chilled cooler.

21. In the field logbook and on the boring log, describe sample lithology by observing cuttings and/or the bottom end of the liner.

22. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.

23. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.

24. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans. Backfill bore hole as specified in project-specific plans.

25. Decontaminate split-spoons and other small sampling equipment according to CDM Federal SOP 4-5 before proceeding to other sampling locations.

26. Complete the field logbook entry and other forms, being sure to record all relevant information before leaving the site.

27. Properly package all samples for shipment to laboratories and complete all necessary sample shipment documentation. Remand custody of the samples to the appropriate personnel. See CDM Federal SOPs 1-2 and 2-1 or site-specific plans.

#### 5.2.4 Shelby Tube Sampling

**Note**: Steps 1 through 11 describe activities to be performed by a licensed drilling contractor, not CDM personnel.

The following steps must be followed when collecting samples using the Shelby tube:

1. Remove any pavement and subbase material from an area of twice the bit diameter, if necessary.

2. The drilling rig will be decontaminated at a separate location prior to drilling.

3. Attach the hollow-stem auger with the cutting head, plug, and center rod(s).
4. Begin drilling and proceed to the first designated sample depth, adding auger(s) as necessary.
5. Upon reaching the designated sample depth, slightly raise the auger(s) to disengage the cutting head, and rotate the auger without advancement to clean cuttings from the bottom of the hole.
6. Remove the plug and center rods.
7. Attach a head assembly to a decontaminated Shelby tube. Attach the Shelby tube assembly to the center rods.
8. Lower the Shelby tube and center rods into the hollow-stem augers and seat it at the bottom. Be sure to leave 30 inches or more of center rod above the lowest point to the hydraulic piston's extension.
9. Use the rig's hydraulic drive to push the Shelby tube into undisturbed soil. The tube should be pushed with a steady force. Note the pressure used to push the Shelby tube in the field logbook.
10. When the Shelby tube has been advanced its full length or to refusal, back off the hydraulic pistons. Attach a hoisting plug to the upper end of the center rod, twist to break off the sample, and pull the apparatus out of the hole with the rig winch.
11. Retrieve the Shelby tube to the surface, detach it from the center rod, and remove the head assembly.
12. Since the typical intent of Shelby tube sampling is for engineering purposes and an undisturbed sample is required, the tube ends should be sealed immediately. Sealing is accomplished by filling any void space in the tube with beeswax, then placing caps on the ends of the tube and taping caps into place. The top and bottom ends of the tube should be marked and the tube transported to the laboratory in an upright position. Indicate boring/well number and depth on outside of liner.
13. Wipe sealed tubes with a clean Kimwipe or paper towel.
14. Place sealed tubes in zip-top plastic bags and seal bags. Pack samples in a chilled cooler.
15. Continue to advance the borehole to the next sampling point. Collect samples as outlined above.
16. When sampling is complete, remove the drilling rig to the heavy equipment decontamination area.
17. Dispose of cuttings, plastic sheeting, etc., as specified in the site-specific plans.
18. Complete the field logbook entry, being sure to record all relevant information before leaving the site. These methods may be used if directed by the EPA region, client, or governing sample plan.

#### 5.2.5 Field Sampling/Preservation Methods

The following three sections contain SW 846 Methods for sampling and field preservation. These methods include EN CORE™ Sampler Method for low-level detection limits, EN CORE Sampler Method for high-level limits/screening, and methanol preservation. These methods may be used if required by the EPA Region, client, or governing sample plan. These methods are very detailed and contain equipment requirements at the beginning of each section.

When collecting soil samples using the EN CORE Sampler Method, collection of soil for moisture content analysis is required. Results of this analysis are used to adjust "wet" concentration results to "dry" concentrations to meet analytical method requirements.

**Note**: Some variations from these methods, (e.g., sample volume) may be required depending on the contracted analytical laboratory.

*5.2.5.1 EN CORE Sampler Collection for Low Level Analyses (≥1 μg/kg)*
**EN CORE Sampling Equipment Requirements**
The following equipment is required for low-level analysis:

- Three 5 grams (g) samplers

**Note:** The sample volume requirements specified are general requirements. Actual sample volume and/or container sizes may vary depending on client or laboratory requirements.

- One 110-milliliter (mL) (4-ounce [oz.]) widemouth glass jar or applicable container for moisture analysis
- One T-handle
- Paper towels

**EN CORE Sampling Steps for Low Level Analysis**

1. Remove sampler and cap from package and attach T-handle to sampler body.

2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

3. Extract sampler and wipe the sampler head with a paper towel so that the cap can be tightly attached.

4. Push cap on with a twisting motion to secure to the sampler body.

5. Rotate the sampler stem counterclockwise until stem locks in place to retain sample within the sampler body.

6. Fill out sample label and attach to sampler.

7. Repeat procedure for the remaining two samplers.

8. Collect moisture sample in 110-mL (4-oz.) widemouth jar using a clean stainless steel spoon or trowel.

9. Store samplers at 4 degrees (°) Celsius (C), ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

**Note:** Verify requirements for extraction/holding times.

*5.2.5.2 EN CORE Sampler Collection for High Level Analyses (≥200 µg/kg)*

**EN CORE Sampling Equipment Requirements**

The following equipment is required for high-level analysis:

- One 5-g sampler or one 25-g sampler (The sampler size used will be dependent on client and laboratory requirements.
- One 110-mL (4-oz.) widemouth glass jar or applicable container specified for moisture analysis.
- One T-handle.
- Paper towels.

**EN CORE Sampling Steps for High Level Analysis**

1. Remove sample and cap from package and attach T-handle to sampler body.

2. Quickly push the sampler into a freshly exposed surface of soil until the sampler is full. The O-ring will be visible within the hole on the side of the T-handle. If the O-ring is not visible within this window, then the sampler is not full.

3. Use clean paper toweling to quickly wipe the sampler head so that the cap can be tightly attached.

4. Push cap on with a twisting motion to attach cap.

5. Fill out a sample label and attach to sampler.

6. Rotate sampler stem counterclockwise until the stem locks in place to retain the sample within the sampler body.

7. Collect moisture sample in 110-mL (4-oz.) widemouth jar or designated container using a clean stainless steel spoon or trowel.

8. Store samplers at 4°C, ±2°C. Samples must be shipped and delivered to the analytical laboratory for extraction within 48 hours.

**Note:** Verify requirements for extraction/holding times.

*5.2.5.3 Methanol Preservation Sampling for High Level Analyses (≥200 µg/kg)*

**Methanol Preservation Sampling Equipment Requirements**

- One pre-weighed jar that contains methanol or a pre-weighed empty jar accompanied with a pre-weighed vial that contains methanol (laboratory grade)
- One dry weight cup

- Weighing balance that accurately weighs to 0.01 g (with accuracy of ±0.1 g)
- Set of balance weights used in daily balance calibration
- Latex gloves
- Paper towels
- Cutoff plastic syringe or other coring device to deliver 5 g or 25 g of soil

**Sampling Preservation Steps**

1. Wear gloves during all handling of pre-weighed vials.

2. Weigh the vial containing methanol preservative to the nearest 0.01 g. If the weight of the vial with methanol varies by more than 0.01 g from the original weight recorded on the vial, discard the vial. If the weight is within tolerance, it can be used for soil preservation/collection below.

3. Take the empty jar or the jar that contains the methanol preservative.

4. Quickly collect a 5-g or 25-g sample using a cutoff plastic syringe or other coring device designed to deliver 5 g or 25 g of soil from a freshly exposed surface of soil. The 5-g or 25-g size used is dependent on client and laboratory requirements.

5. Carefully wipe the exterior of the collection device with a clean paper towel.

6. Quickly transfer the soil to an empty jar or a jar that contains methanol. If extruding into a jar that contains methanol, be careful not to splash the methanol outside of the vial. Again, the type of jar used is dependent on the client or laboratory requirements.

7. If the jar used to collect the soil plug was empty before the soil was added, immediately preserve with the methanol provided, using only one vial of methanol preservative per sample jar.

8. Using the paper toweling, remove any soil off of the vial threads and cap the jar.

9. Weigh the jar with the soil in it to the nearest 0.01 g and record the weight on the sample label.

10. Collect dry weight sample using a clean stainless steel spoon or trowel.

11. Store samples at 4°, ±2°C.

12. Ship sample containers with plenty of ice in accordance with DOT regulations (CORROSIVE. FLAMMABLE LIQUID. POISON) to the laboratory.

## 6.0 Restrictions/Limitations

Basket or spring retainers may be needed for split-spoon sampling in loose, sandy soils.

Shelby tubes may not retain the sample in loose, sandy soils.

## 7.0 References

American Society for Testing and Materials, *Standard Test Method for Penetration Test and Split Barrel Sampling of Soils*, Standard Method D1586-99, 1999.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements for Field Methods*, DOE/HWP-69/R2, September 1996.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures for Site Characterizations*, DOE/HWP-100/R1, September 1996 or current revision.

U.S. Environmental Protection Agency, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846)*, Third Edition, November 1986, (as amended by Updates I, II, IIA, IIB, III, and IIIA, June 1997). Method 5035 (**Note:** § 6.2.1.8 of this method says samples stored in En Core™ samplers should be analyzed within 48 hours or transferred to soil sample vials in the laboratory within 48 hours): December 1996, Revision O, Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples.

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## 1.0 Packaging and Shipping of All Samples

This standard operating procedure (SOP) applies to the packaging and shipping of all environmental samples. If the sample is preserved or radioactive, the following sections may also be applicable.

**Section 2.0** – Packaging and Shipping Samples Preserved with Methanol
**Section 3.0** – Packaging and Shipping Samples Preserved with Sodium Hydroxide
**Section 4.0** – Packaging and Shipping Samples Preserved with Hydrochloric Acid
**Section 5.0** – Packaging and Shipping Samples Preserved with Nitric Acid
**Section 6.0** – Packaging and Shipping Samples Preserved with Sulfuric Acid
**Section 7.0** – Packaging and Shipping Limited-Quantity Radioactive Samples

### 1.1 Objective

The objective of this SOP is to outline the requirements for the packaging and shipment of environmental samples. Additionally, Sections 2.0 through 7.0 outline requirements for the packaging and shipping of regulated environmental samples under the Department of Transportation (DOT) Hazardous Materials Regulations, the International Air Transportation Association (IATA), and International Civil Aviation Organization (ICAO) Dangerous Goods Regulations for shipment by air and applies only to domestic shipments. This SOP does not cover the requirements for packaging and shipment of equipment (including data loggers and self-contained breathing apparatus [SCBAs] or bulk chemicals that are regulated under the DOT, IATA, and ICAO.

### 1.2 Background

#### 1.2.1 Definitions

**Environmental Sample** - An aliquot of air, water, plant material, sediment, or soil that represents the contaminant levels on a site. Samples of potential contaminant sources, like tanks, lagoons, or non-aqueous phase liquids are normally not "environmental" for this purpose. This procedure applies only to environmental samples that contain less than reportable quantities for any foreseeable hazardous constituents according to DOT regulations promulgated in 49 CFR - Part 172.101 Appendix A.

**Custody Seal** – A custody seal is a narrow adhesive-backed seal that is applied to individual sample containers and/or the container (i.e., cooler) before offsite shipment. Custody seals are used to demonstrate that sample integrity has not been compromised during transportation from the field to the analytical laboratory.

**Inside Container** – The container, normally made of glass or plastic, that actually contacts the shipped material. Its purpose is to keep the sample from mixing with the ambient environment.

**Outside Container** – The container, normally made of metal or plastic, that the transporter contacts. Its purpose is to protect the inside container.

**Secondary Containment** – The outside container provides secondary containment if the inside container breaks (i.e., plastic overpackaging if liquid sample is collected in glass).

**Excepted Quantity** – Excepted quantities are limits to the mass or volume of a hazardous material in the inside and outside containers below which DOT, IATA, ICAO regulations do not apply. The excepted quantity limits are very low. Most regulated shipments will be made under limited quantity.

**Limited Quantity** – Limited quantity is the maximum amount of a hazardous material below which there are specific labeling or packaging exceptions.

**Performance Testing** – Performance testing is the required testing of outer packaging. These tests include drop and stacking tests.

**Qualified Shipper** – A qualified shipper is a person who has been adequately trained to perform the functions of shipping hazardous materials.

#### 1.2.2 Discussion

Proper packaging and shipping is necessary to ensure the protection of the integrity of environmental samples shipped for analysis. These shipments are potentially subject to regulations published by DOT, IATA, or ICAO. Failure to abide by these rules places both CDM and the individual employee at risk of serious fines. The analytical holding times for the samples must not be exceeded. The samples should be packed in time to be shipped for overnight delivery. Make arrangements with the laboratory before sending samples for weekend delivery.

#### 1.2.3 Associated Procedure

- CDM Federal SOP 1-2, Sample Custody

### 1.3 Required Equipment

- Coolers with return address of the appropriate CDM office
- Heavy-duty plastic garbage bags
- Plastic zip-type bags, small and large
- Clear tape
- Nylon reinforced strapping tape
- Duct tape
- Vermiculite (or an equivalent nonflammable material that is inert and absorbent)*
- Bubble wrap (optional)
- Ice
- Custody seals
- Completed chain-of-custody record or contract laboratory program (CLP) custody records, if applicable
- Completed bill of lading
- “This End Up” and directional arrow labels

* Check for any client-specific or laboratory requirements related to the use of absorbent packaging materials.

### 1.4 Packaging Environmental Samples

The following steps must be followed when packing sample bottles and jars for shipment:

1. Verify the samples undergoing shipment meet the definition of "environmental sample" and are not a hazardous material as defined by DOT. Professional judgment and/or consultation with qualified persons such as the appropriate health and safety coordinator or the health and safety manager should be observed.

2. Select a sturdy cooler in good repair. Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler. Line the cooler with a large heavy-duty plastic garbage bag.

3. Be sure the caps on all bottles are tight (will not leak); check to see that labels and chain-of-custody records are completed properly (SOP 1-2, Sample Custody).

4. Place all bottles in separate and appropriately sized plastic zip-top bags and close the bags. Up to three VOA vials may be packed in one bag. Binding the vials together with a rubber band on the outside of the bag, or separating them so that they do not contact each other, will reduce the risk of breakage. Bottles may be wrapped in bubble wrap. Optionally, place three to six VOA vials in a quart metal can and then fill the can with vermiculite or equivalent. **Note**: Trip blanks must be included in coolers containing VOA samples.

5. Place 2 to 4 inches of vermiculite (or equivalent) into a cooler that has been lined with a garbage bag, and then place the bottles and cans in the bag with sufficient space to allow for the addition of packing material between the bottles and cans. It is preferable to place glass sample bottles and jars into the cooler vertically. Glass containers are less likely to break when packed vertically rather than horizontally.

6. While placing sample containers into the cooler, conduct an inventory of the contents of the shipping cooler against the chain-of-custody record. The chain-of-custody with the cooler should reflect only those samples within the cooler.

7. Put ice in large plastic zip-top bags (double bagging the zip-tops is preferred) and properly seal. Place the ice bags on top of and/or between the samples. Several bags of ice are required (dependant on outdoor temperature, staging time, etc.) to maintain the cooler temperature at approximately 4° Celsius (C) if the analytical method requires cooling. Fill all remaining space between the bottles or cans with packing material. Securely fasten the top of the large garbage bag with fiber or duct tape.

8. Place the completed chain-of-custody record or the CLP traffic report form (if applicable) for the laboratory into a plastic zip-top bag, seal the bag, tape the bag to the inner side of the cooler lid and close the cooler.

9. The cooler lid shall be secured with nylon reinforced strapping tape by wrapping each end of the cooler a minimum of two times. Attach a completed chain-of-custody seal across the opening of the cooler on opposite sides. The custody seals should be affixed to the cooler with half of the seal on the strapping tape so that the cooler cannot be opened without breaking the seal. Complete two more wraps around with fiber tape and place clear tape over the custody seals.

10. The shipping container lid must be marked **"THIS END UP"** and arrow labels that indicate the proper upward position of the container should be affixed to the cooler. A label containing the name and address of the shipper (CDM) shall be placed on the outside of the container. Labels used in the shipment of hazardous materials (such as Cargo Only Air Craft, Flammable Solids, etc.) are not permitted on the outside of containers used to transport environmental samples and shall not be used. The name and address of the laboratory shall be placed on the container, or when shipping by common courier, the bill of lading shall be completed and attached to the lid of the shipping container.

## 2.0 Packaging and Shipping Samples Preserved with Methanol

### 2.1 Containers

- The maximum volume of methanol in a sample container is limited to 30 ml.
- The sample container must not be full of methanol.

### 2.2 Responsibility

It is the responsibility of the qualified shipper to:

- Ensure that the samples undergoing shipment contain no other contaminant that meets the definition of "hazardous material" as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

### 2.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Inner packing may consist of glass or plastic jars
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Survey documentation (if shipping from Department of Energy [DOE] or radiological sites)
- Class 3 flammable liquid labels
- Orientation labels
- Consignor/consignee labels

### 2.4 Packaging Samples Preserved with Methanol

The following steps are to be followed when packaging limited-quantity sample shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.

- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (Maximum of 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)
- Total volume of methanol per shipping container must not exceed 500 ml.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

**Methanol Mixture**
**UN1230**
**LTD. QTY.**

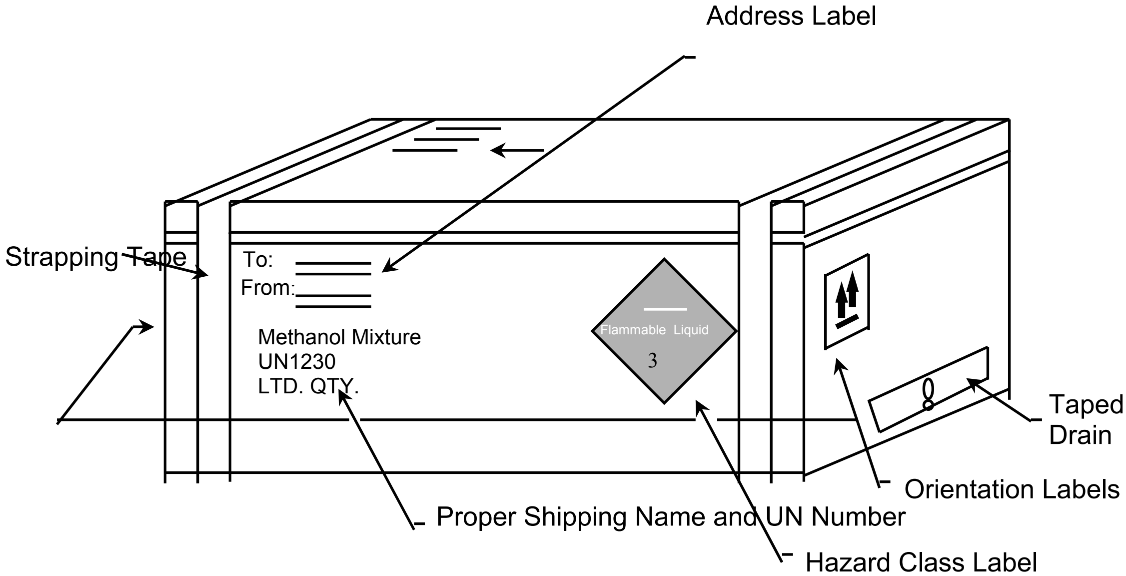
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Flammable Liquid label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

**Note**: No marking or labeling can be obscured by strapping or duct tape.

**Note**: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

**Figure 1 - Example of Cooler Label/Marking Locations**




## 3.0 Packaging and Shipping Samples Preserved with Sodium Hydroxide

### 3.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

**Excepted Quantities of Sodium Hydroxide Preservatives**

| *Preservative* | | *Desired in Final Sample* | | *Quantity of Preservative (ml) for Specified Container* | | | | |
|---|---|---|---|---|---|---|---|---|
| | | pH | Conc. | 40 ml | 125 ml | 250 ml | 500 ml | 1 L |
| NaOH | 30% | >12 | 0.08% | | .25 | 0.5 | 1 | 2 |

5 drops = 1 ml

### 3.2 Responsibility

It is the responsibility of the qualified shipper to determine the amount of preservative in each sample so that accurate determination of quantities can be made.

### 3.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3:

- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test
- Inner packings may consist of glass or plastic jars no larger than 1 pint
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

### 3.4 Packaging Samples Preserved with Sodium Hydroxide

Samples containing NaOH as a preservative that exceed the excepted concentration of 0.08 percent (2 ml of a 30 percent NaOH solution per liter) may be shipped as a limited quantity per packing instruction Y819 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- The total volume of sample in each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.

- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

**Sodium Hydroxide Solution**
**UN1824**
**LTD. QTY.**

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

**Note**: Samples meeting the exception concentration of 0.08 percent NaOH by weight may be shipped as non-regulated or non-hazardous following the procedure in Section 1.4.

**Note**: No marking or labeling can be obscured by strapping or duct tape.

**Note**: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

## 4.0 Packaging and Shipping Samples Preserved with Hydrochloric Acid

### 4.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

**Excepted Quantities of Hydrochloric Acid Preservatives**

| Preservative | | Desired in Final Sample | | Quantity of Preservative (ml) for Specified Container | | |
|---|---|---|---|---|---|---|
| | | pH | Conc. | 40 ml | 125 ml | 250 ml |
| HCl | 2N | <1.96 | 0.04% | .2 | .5 | 1 |

5 drops = 1 ml

### 4.2 Responsibility
It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

### 4.3 Additional Required Equipment
The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packing may consist of glass or plastic jars no larger than 1 pint.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

### 4.4 Packaging Samples Preserved with Hydrochloric Acid
The following steps are to be followed when packaging limited-quantity sample shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each container (40-ml VOA vials) in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place wrapped containers inside a polyethylene bottle filled with vermiculite; seal the bottle. (No more than 4 VOA vials will fit inside a 500-ml wide-mouth polyethylene bottle.)

- Total volume of sample inside each cooler must not exceed 1 liter.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

**Hydrochloric Acid Solution**
**UN1789**
**LTD. QTY.**

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

**Note**: Samples containing less than the exception concentration of 0.04 percent HCl by weight will be shipped as non-regulated or non-hazardous following the procedure in Section 1.4.

**Note**: No marking or labeling can be obscured by strapping or duct tape.

**Note**: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.

- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

# 5.0 Packaging and Shipping Samples Preserved with Nitric Acid

## 5.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

**Excepted Quantities of Nitric Acid Preservatives**

| Preservative | | Desired in Final Sample | | Quantity of Preservative (ml) for Specified Container | | | | |
|---|---|---|---|---|---|---|---|---|
| | | pH | Conc. | 40 ml | 125 ml | 250 ml | 500 ml | 1 L |
| $HNO_3$ | 6N | <1.62 | 0.15% | | 2 | 4 | 5 | 8 |

5 drops = 1 ml

## 5.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

## 5.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

## 5.4 Packaging Samples Preserved with Nitric Acid

Samples containing $HNO_3$ as a preservative that exceed the excepted concentration of 0.15 percent $HNO_3$ will be shipped as a limited quantity per packing instruction Y807 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity sample shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name

- Project number
- Date and time of sample collection
- Sample location
- Sample identification number
- Collector's initials
- Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody)

- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

**Nitric Acid Solution (with less than 20 percent)**
**UN2031**
**Ltd. Qty.**

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

**Note**: Samples meeting the exception concentration of 0.15 percent $HNO_3$ by weight will be shipped as non-regulated or non-hazardous following the procedure in Section 1.4.

**Note**: No marking or labeling can be obscured by strapping or duct tape.

**Note**: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

## 6.0 Packaging and Shipping Samples Preserved with Sulfuric Acid

### 6.1 Containers

The inner packaging container (and amount of preservative) that may be used for these shipments includes:

**Excepted Quantities of Sulfuric Acid Preservatives**

| *Preservative* | | *Desired in Final Sample* | | *Quantity of Preservative (ml) for Specified Container* | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **pH** | **Conc.** | **40 ml** | **125 ml** | **250 ml** | **500 ml** | **1 L** |
| $H_2SO_4$ | 37N | <1.15 | 0.35% | .1 | .25 | 0.5 | 1 | 2 |

5 drops = 1 ml

### 6.2 Responsibility

It is the responsibility of the qualified shipper to:

- Determine the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT
- Determine the amount of preservative in each sample so that accurate determination of quantities can be made

### 6.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Inner packings may consist of glass or plastic jars no larger than 100 ml.
- Outer packaging (for limited quantities) insulated cooler that has passed the ICAO drop test.
- Survey documentation (if shipping from DOE or radiological sites)
- Class 8 corrosive labels
- Orientation labels
- Consignor/consignee labels

## 6.4 Packaging of Samples Preserved with Sulfuric Acid

Samples containing $H_2SO_4$ as a preservative that exceed the excepted concentration of 0.35 percent will be shipped as a limited quantity per packing instruction Y809 of the IATA/ICAO Dangerous Goods Regulations.

The following steps are to be followed when packaging limited-quantity samples shipments.

- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number
  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
  - Preservative (note amount of preservative used in miscellaneous section of the chain-of-custody form)
- Wrap each glass container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place the bubble-wrapped container into a 2.7-mil zip-type bag, removing trapped air.
- Place glass containers inside a polyethylene bottle filled with vermiculite; seal the bottle.
- Place sufficient amount of vermiculite in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- Place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- The maximum volume of preserved solution in the cooler must not exceed 500 ml.
- The maximum weight of the cooler shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- Wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Mark the outside of the cooler with the proper shipping name of the contents, corresponding UN number, and LTD. QTY. (as shown below).

**Sulfuric Acid Solution**
**UN2796**
**LTD. QTY.**

- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix a Corrosive label to the outside of the cooler.
- Affix package orientation labels on two opposite sides of the cooler.
- Secure the marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of cooler labeling/marking locations is shown in Figure 1.

**Note**: Samples containing less than the exception concentration of 0.35 percent $H_2SO_4$ by weight will be shipped as non-regulated or non-hazardous in accordance with the procedure described in Section 1.4.

**Note**: No marking or labeling can be obscured by strapping or duct tape.

**Note**: The inner packaging of dangerous goods must be placed into the designated cooler for shipment. Other non-regulated environmental samples may be added to the cooler for shipment.

- When shipping from a DOE facility, the cooler will be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Complete the Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity (Appendix A).
- Complete a Dangerous Goods Airbill.

## 7.0 Packaging and Shipping Limited-Quantity Radioactive Samples

### 7.1 Containers

The inner packaging containers that may be used for these shipments include:

- Any size sample container

### 7.2 Description/Responsibilities

- The qualified shipper will determine that the samples undergoing shipment contain no other contaminant that meets the definition of hazardous material as defined by DOT.
- The qualified shipper will ship all samples that meet the Class 7 definition of radioactive materials and meet the activity requirements specified in Table 7 of 49 CFR 173.425, as Radioactive Materials in Limited Quantity. The qualified shipper will verify that all packages and their contents meet the requirements of 49 CFR 173.421, *Limited Quantities of Radioactive Materials*.
- The packaging used for shipping will meet the general requirements for packaging and packages specified in 49 CFR 173.24 and the general design requirements provided in 173.410. These standards state that a package must be capable of withstanding the effects of any acceleration, vibration, or vibration resonance that may arise under normal condition of transport without any deterioration in the effectiveness of the closing devices on the various

receptacles or in the integrity of the package as a whole and without loosening or unintentionally releasing the nuts, bolts, or other securing devices even after repeated use.

- If the shipment is from a DOE facility, radiological screenings will be completed on all samples taken. The qualified shipper will review the results of each screening (alpha, beta, and gamma speciation). Samples will not be shipped offsite until the radiological screening has been performed.
- The total activity for each package will not exceed the relevant limits listed in Table 7 of 49 CFR 173.425. The $A_2$ value of the material will be calculated based on all radionuclides found during previous investigations (if any) in the area from which the samples are derived. The $A_2$ values to be used will be the most restrictive of all potential radionuclides as listed in 49 CFR 173.435.
- The radiation level at any point on the external surface of the package bearing the sample(s) will not exceed 0.005 mSv/hour (0.5 mrem/hour). These will be verified by dose and activity monitoring prior to shipment of the package.
- The removable radioactive surface contamination on the external surface of the package will not exceed the limits specified in 49 CFR 173.443(a). CDM will apply the DOE-established free release criteria for removable surface contamination of less than 20 dpm/100 $cm^2$ (alpha) and 1,000 dpm/100 $cm^2$ (beta/gamma). It should be noted that these values are more conservative than the DOT requirements for removable surface contamination.
- The qualified shipper will verify that the outside of the inner packaging is marked "Radioactive."
- The qualified shipper will verify that the excepted packages prepared for shipment under the provisions of 49 CFR 173.421 have a notice enclosed, or shown on the outside of the package, that reads, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**

### 7.3 Additional Required Equipment

The following equipment is needed in addition to the required equipment listed in Section 1.3.

- Survey documentation/radiation screening results (if shipping from DOE or radiological sites)
- Orientation labels
- Excepted quantities label
- Consignor/consignee labels

### 7.4 Packaging of Limited-Quantity Radioactive Samples

The following steps are to be followed when packaging limited-quantity sample shipments.

- The cooler is to be surveyed by a qualified radiation control technician to ensure that radiation flux on exterior surfaces does not exceed 0.5 mrem/h on all sides. This survey will be documented and the results reviewed by the qualified shipper.
- Tape any interior opening in the cooler (drain plug) from the inside to ensure control of interior contents. Also, tape the drain plug from the outside of the cooler.
- All sample containers will be properly labeled and the label protected with waterproof tape prior to sampling.
- At a minimum the label must contain:
  - Project name
  - Project number

  - Date and time of sample collection
  - Sample location
  - Sample identification number
  - Collector's initials
- This step is optional; wrap each container in bubble wrap (secure with waterproof tape) to prevent breakage.
- Place sufficient amount of vermiculite, or approved packaging material, in the bottom of the cooler to absorb any leakage that may occur.
- Place a garbage bag in the cooler.
- Pack the samples appropriately inside the garbage bag (bottles placed upright) to prevent movement during shipment.
- If required, place a sufficient amount of double-bagged ice around the samples to maintain the required temperature during shipment.
- Seal the garbage bag by tieing or taping.
- Place a label marked Radioactive on the outside of the sealed bag.
- Enclose a notice that includes the name of the consignor or consignee and the following statement: **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."**
- Note that both DOT and IATA apply different limits to the quantity in the inside packing and in the outside packing.
- The maximum weight of the package shall not exceed 30 kg (66 lbs) for any limited-quantity shipment of dangerous goods.
- Secure the chain-of-custody form (placed inside a zip-type bag) to the interior of the cooler lid.
- If the shipment is from a DOE or other facility, place the results of the radiation screen and cooler/sample survey with the chain-of-custody.
- If a cooler is used, wrap strapping tape or duct tape around both ends of the cooler and around the cooler lid.
- Affix custody seals to opposite sides of the cooler lid. Cover the custody seals with clear waterproof tape.
- Place a label on the front of the cooler with the company name, contact name, phone number, full street address, and state with zip code for both shipper and recipient.
- Affix package orientation labels on two opposite sides of the cooler/package.
- Affix a completed Excepted Quantities label to the side of the cooler/package.
- Secure any marking and labels to the surface of the cooler with clear waterproof tape to prevent accidental removal during shipment.
- An example of the cooler labeling/marking is shown in Figure 2.

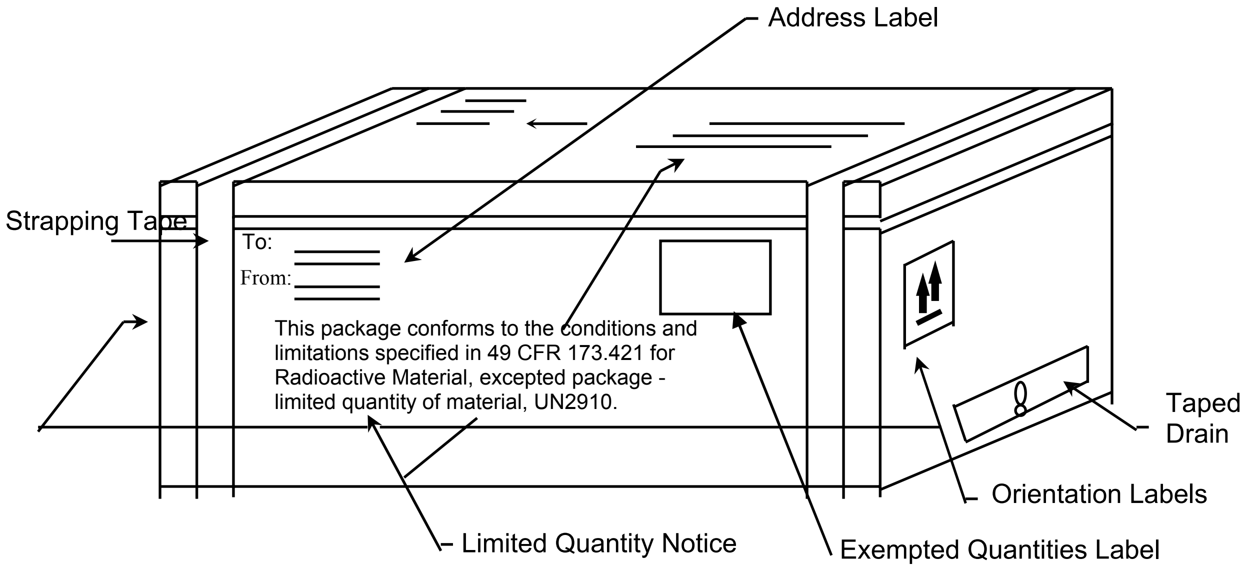
  **Note**: No marking or labeling can be obscured by strapping or duct tape.

- Complete the Shipment Quality Assurance Checklist (Appendix B).

  **Note**: Except as provided in 49 CFR 173.426, the package will not contain more than 15 grams of $^{235}U$.

  **Note**: A declaration of dangerous goods is not required.

**Figure 2 - Radioactive Material – Limited-Quantity Cooler Marking Example**




## 8.0 References

U.S. Environmental Protection Agency, *Sampler's Guide to the Contract Laboratory Program*, EPA/540/P-90/006, December 1990.

U.S. Environmental Protection Agency, Region IV, *Standard Operating Procedures and Quality Assurance Manual*, February 1991.

U.S. Environmental Protection Agency Rule, 40 CFR 136.

# Appendix A

## Dangerous Goods and Hazardous Materials Inspection Checklist for Shipping Limited-Quantity

*Sample Packaging*

| Yes | No | N/A | |
|---|---|---|---|
| ❑ | ❑ | ❑ | The VOA vials are wrapped in bubble wrap and placed inside a zip-type bag. |
| ❑ | ❑ | ❑ | The VOA vials are placed into a polyethylene bottle, filled with vermiculite, and tightly sealed. |
| ❑ | ❑ | ❑ | The drain plug is taped inside and outside to ensure control of interior contents. |
| ❑ | ❑ | ❑ | The samples have been placed inside garbage bags with sufficient bags of ice to preserve samples at 4°C. |
| ❑ | ❑ | ❑ | The cooler weighs less than the 66-pound limit for limited-quantity shipment. |
| ❑ | ❑ | ❑ | The garbage bag has been sealed with tape (or tied) to prevent movement during shipment. |
| ❑ | ❑ | ❑ | The chain-of-custody has been secured to the interior of the cooler lid. |
| ❑ | ❑ | ❑ | The cooler lid and sides have been taped to ensure a seal. |
| ❑ | ❑ | ❑ | The custody seals have been placed on both the front and back hinges of the cooler, using waterproof tape. |

*Air Waybill Completion*

| Yes | No | N/A | |
|---|---|---|---|
| ❑ | ❑ | ❑ | Section 1 has the shipper's name, company, and address; the account number, date, internal billing reference number; and the telephone number where the shipper can be reached. |
| ❑ | ❑ | ❑ | Section 2 has the recipient's name and company along with a telephone number where they can be reached. |
| ❑ | ❑ | ❑ | Section 3 has the **Bill Sender** box checked. |
| ❑ | ❑ | ❑ | Section 4 has the **Standard Overnight** box checked. |
| ❑ | ❑ | ❑ | Section 5 has the **Deliver Weekday** box checked. |
| ❑ | ❑ | ❑ | Section 6 has the number of packages and their weights filled out. Was the total of all packages and their weights figured up and added at the bottom of Section 6? |
| ❑ | ❑ | ❑ | Under the **Transport Details** box, the **Cargo Aircraft Only** box is obliterated, leaving only the **Passenger and Cargo Aircraft** box. |
| ❑ | ❑ | ❑ | Under the **Shipment Type**, the **Radioactive** box is obliterated, leaving only the **Non-Radioactive** box. |
| ❑ | ❑ | ❑ | Under the **Nature and Quantity of Dangerous Goods** box, the **Proper Shipping Name, Class or Division, UN or ID No., Packing Group, Subsidiary Risk, Quantity and Type of Packing, Packing Instructions, and Authorization** have been filled out for the type of chemical being sent. |
| ❑ | ❑ | ❑ | The **Name, Place and Date, Signature, and Emergency Telephone Number** appears at the bottom of the FedEx Airbill. |
| ❑ | ❑ | ❑ | The statement "In accordance with IATA/ICAO" appears in the **Additional Handling Information** box. |
| ❑ | ❑ | ❑ | The E**mergency Contact Information** at the bottom of the FedEx Airbill is truly someone who can respond any time of the day or night. |

| Proper Shipping Name | Class or Division | UN or ID No. | Packing Group | Sub Risk | Quantity | Packing Instruction | Authorization |
|---|---|---|---|---|---|---|---|
| Hydrochloric Acid Solution | 8 | UN1789 | II | | 1 plastic box × 0.5 L | Y809 | Ltd. Qty. |
| Nitric Acid Solution (with less than 20%) | 8 | UN2031 | II | | 1 plastic box × 0.5 L | Y807 | Ltd. Qty. |
| Sodium Hydroxide Solution | 8 | UN1824 | II | | 1 plastic box × 0.5 L | Y809 | Ltd. Qty. |
| Sulfuric Acid Solution | 8 | UN2796 | II | | 1 plastic box × 0.5 L | Y809 | Ltd. Qty. |
| Methanol | 3 | UN1230 | II | | 1 plastic box × 1 L | Y305 | Ltd. Qty. |

*Sample Cooler Labeling*

| Yes | No | N/A | |
|---|---|---|---|
| ❏ | ❏ | ❏ | The proper shipping name, UN number, and Ltd. Qty. appears on the shipping container. |
| ❏ | ❏ | ❏ | The corresponding hazard labels are affixed on the shipping container; the labels are not obscured by tape. |
| ❏ | ❏ | ❏ | The name and address of the shipper and receiver appear on the top and side of the shipping container. |
| ❏ | ❏ | ❏ | The air waybill is attached to the top of the shipping container. |
| ❏ | ❏ | ❏ | **Up Arrows** have been attached to opposite sides of the shipping container. |
| ❏ | ❏ | ❏ | Packaging tape does not obscure markings or labeling. |

# Appendix B

## Shipment Quality Assurance Checklist

Date: ____________ Shipper: ___________________________ Destination: _______________________

Item(s) Description: ______________________________________________________________________

Radionuclide(s): _________________________________________________________________________

Radiological Survey Results: surface _________________mrem/hr 1 meter _____________________

Instrument Used: Mfgr: ________________________________ Model: ___________________________

S/N: ______________________________________ Cal Date: ___________________________________

### Limited-Quantity or Instrument and Article

| Yes | No | | |
|---|---|---|---|
| ___ | ___ | 1. | Strong tight package (package that will not leak material during conditions normally incidental to transportation). |
| ___ | ___ | 2. | Radiation levels at any point on the external surface of package less than or equal to 0.5 mrem/hr. |
| ___ | ___ | 3. | Removable surface contamination less than 20 dpm/100 $cm^2$ (alpha) and 1,000 dpm/100 $cm^2$ (beta/gamma). |
| ___ | ___ | 4. | Outside inner package bears the marking "Radioactive." |
| ___ | ___ | 5. | Package contains less than 15 grams of $^{235}U$ (check yes if $^{235}U$ not present). |
| ___ | ___ | 6. | Notice enclosed in or on the package that includes the consignor or consignee and the statement, **"This package conforms to the conditions and limitations specified in 49 CFR 173.421 for radioactive material, excepted package-limited quantity of material, UN2910."** |
| ___ | ___ | 7. | Activity less than that specified in 49 CFR 173.425. Permissible package limit: Package Quantity: |
| ___ | ___ | 8. | On all air shipments, the statement **Radioactive Material, excepted package-limited quantity of material** shall be noted on the air waybill. |

Qualified Shipper: ____________________________ Signature: _________________________________

Prepared: Del R. Baird

Technical Review: Sharon Budney

QA Review: James Romig

Approved: Michael C. Malloy 2/24/04
Signature/Date

Issued: 2/18/04
Signature/Date

## 1.0 Objective

This standard operating procedure (SOP) governs lithologic logging of core, cuttings, split-spoon samples, and subsurface samples collected during field operations at sites where environmental investigations are performed by CDM Federal Programs Corporation (CDM). The purpose of this SOP is to present a set of descriptive protocols and standardized reporting formats to be used by all investigators in making lithologic observations. It prescribes protocols for recording basic lithologic data including, but not limited to, lithologic names, texture, composition, color, sedimentary structures, bedding, lateral and vertical contacts, and secondary features such as fractures and bioturbation.

The goal of this SOP is to provide a set of instructions to produce uniform lithologic descriptions and to present a list of references to help in this task.

## 2.0 Background

### 2.1 Definitions

The following list of definitions corresponds to the description sequences outlined in Section 5.2.1. They are provided to aid the lithologic logger in what to look for when following the sequences. An example lithologic log is given in Attachment A.

**Name of Sediment or Rock** - In naming unconsolidated sediments, the logger should use field equipment and reference charts to help identify the grain-size distribution and should name the material according to the procedure in Section 5.2.1. In naming sedimentary, igneous, and metamorphic rocks, the logger should examine the specimen for mineralogy and use the appropriate classification chart in the attachments.

**Texture** - In examining unconsolidated sediments, the texture shall refer to the grain-size distribution, particle angularity, sorting, and packing. The logger should provide estimates of the grain sizes present using Attachment B and C. When larger particles such as cobbles are present, determine the size of the particles and give a percentage estimate. The sediment particles should be examined for angularity by comparing with Attachment B and the sorting should be determined by percentage estimation. The logger should note that the Unified Soil Classification System (USCS) uses the term grading to describe how the materials are sorted. (A poorly sorted unconsolidated material is well graded.) In examining igneous rocks, texture refers to whether the specimen is aphanitic, phaneritic, glassy, fragmental, porphyritic, or pegmatitic. Attachment D has more specific definitions of these terms. For metamorphic rocks, texture refers to whether the specimen has a foliate structure (slaty, phyllitic, schistose, or gneissic) or nonfoliate structure (granular).

**Color** - Color may be determined using the appropriate Munsell color chart (soil or rock) and listing the Munsell number that corresponds to the color. If an unconsolidated material is mottled in color, the ranges in color should be described. When describing core samples with several individual colors such as in phaneritic textures, individual color names should be listed, and an overall best color name should be given.

**Sedimentary Structures** - This term refers primarily to unconsolidated sediments and sedimentary rocks. There are several different sedimentary structures, and the logger is referred to Compton's *Manual of Field Geology* (1962) book for more details. Among the more common structures are bedding, cross-bedding, laminations, and burrows. These structures should only be included in the description if found in the samples.

**Degree of Consolidation** - The degree of consolidation is applicable to sedimentary rocks and unconsolidated sediments and refers to how well the material has been indurated. Unconsolidated sediments may be compacted somewhat and should be described as loose, moderately compacted, or strongly compacted. In some cases they may be slightly cemented by caliche and should be described as slightly cemented, moderately cemented, or strongly cemented. Sedimentary rocks are typically indurated but may vary in the degree of cementation. These materials should be described as friable, moderately friable, or well indurated. When describing the cementing material, a test for reaction to hydrochloric acid (HCl) should be done and results recorded under the description. If the logger believes he/she can identify the cementing material, then it should be included in the description.

**Moisture Content** - Moisture content refers to the amount of water within the sediment or the matrix. Typically sedimentary rocks and unconsolidated sediments may have water within and should be described as dry, moist, or wet. Igneous and metamorphic rocks may have water within fractures and cavities. The presence of water and pertinent observations that may help in site evaluation in these rocks should be noted.

**Presence of Fractures, Cavities, and Secondary Mineralization** - The rock types that may be encountered during drilling may have fractures or joints present within them. Should fractures be observed, they should be noted and a description as to the density of fractures should be given. Cavities or vugs may be present, and the density of voids as well as a size estimation should be given. If fractures or cavities contain evidence of secondary minerals such as zeolites, clays, or iron oxides, then a description of the mineral fill should be added.

**Evidence of Contamination** - The logger should examine the core and note any obvious signs of contamination such as streaking, free product, odor, or discoloration. These observations should be noted in the field book as should any readings from the photoionization or flame ionization detector (PID/FID). PID/FID hits should be recorded on the Lithologic Log Form also.

**Description of Contacts** - The logger should note any significant change in lithology. These changes may be gradational contacts within sediments or may be sharp contacts such as sediments over rocks. The contacts should be noted as to whether they are erosional, gradational, or sharp, and the depth below the surface should be noted.

**Composition** - The composition of the rock refers to the mineralogy of the material encountered. For sedimentary rocks, it is important to note the matrix composition and use Attachment E in naming. In igneous and metamorphic rocks, the minerals that make up the rock should be stated and an estimation of their percentage should be noted. The classification charts listed in Attachments D and F provide a description of common compositions.

**Degree of Vitrification** - This term is applicable to volcanic rocks and refers to the degree of welding in pyroclastic materials. Describe these rocks as poorly welded, moderately welded, or strongly welded.

### 2.2 Discussion

The installation of monitoring wells, piezometers, and boreholes is a standard practice at many sites requiring environmental investigations. The installation of these devices requires that a trained geologist, or other earth scientist, provide lithologic descriptions as they encounter subsurface material during auguring or drilling. In evaluating these lithologic descriptions from different boreholes, monitoring wells, or piezometers, it is sometimes possible to correlate similar units. To help in this task, it is important to provide uniform and consistent descriptions.

In describing lithologies, it is helpful to have a set of references covering items such as the classification of igneous, metamorphic, and sedimentary rocks; grain-size percentage estimation; particle shape; grain-size charts; and lithologic symbols. In order to make lithologic descriptions produced by CDM staff as uniform and consistent as possible, this SOP provides a list of references to be used in the field. This SOP also provides a sequence for recording information on a standardized log form to make descriptions as uniform and consistent as possible.

### 2.3 Associated Procedures

- CDM Federal SOP 4-1, Field Logbook Content and Control

## 3.0 Responsibilities

**Geologist** - The field person performing lithologic logging is responsible for making a consistent and uniform log and for turning in field forms and logbooks to the field team leader (FTL).

**Field Team Leader** - The FTL is responsible for maintaining logbooks and forms and for approving techniques of lithologic logging not specifically described in this SOP.

## 4.0 Required Equipment

The description of subsurface lithologies requires a minor amount of field equipment for the geologist. This section provides a list of equipment to be used by the lithologic logger but does not include equipment such as drill rigs, PID/FID, sampling equipment, and personal protection equipment. The following is a general list of equipment that may be used:

- Field logbook and Lithologic Log Form
- Clipboard
- Dilute (10 percent) HCl
- Plastic sheeting

- PVC sampling trays
- Waterproof pens
- No. 2 sieve
- 10x magnifying hand lens
- Reference field charts

# 5.0 Procedures

## 5.1 Office

- Obtain field logbook and Lithologic Log Forms
- Coordinate schedules/actions with FTL
- Obtain necessary field equipment (i.e., hand lens, 10 percent HCl)
- Obtain CDM reference field charts
- Review field support documents (i.e., sampling plan, health and safety plan)
- Review applicable geologic references such as U.S. Department of Agriculture (USDA) Soil Conservation Survey Soil Surveys and/or geologic maps

### 5.1.1 Documentation

Individuals performing lithologic logging will record their observations in a commercially available, bound field logbook (e.g., Lietz books) and/or on individual Lithologic Log Forms. Lithologic loggers will follow the general procedures for keeping a field logbook (SOP 4-1). When using a bound field logbook, record the same data required on the Lithologic Log Form. Data from the field logbook must be transcribed to the Lithologic Log Form if filling in the form in the field is not feasible. However, the data must be the same as that recorded in the field logbook. Editing of field logbook data is not allowed. In addition, if data are transcribed to the Lithologic Log Form, it should be done within 1 day of the original data recording. All blanks in the Lithologic Log Form must be filled out. If an item is not applicable, an "NA" should be entered.

The Lithologic Log Form should be filled out according to the following instructions:

The top part of the form contains general information. The project name and number must be filled in to identify the site. The date that drilling was started and completed, and the well number within the site should be stated. The name of the person logging the well is recorded as is the total depth drilled. Weather condition descriptions should correlate with what is written in the logbook. The last item to be completed is the name and company of the driller and the type of drill rig and bits used.

The bottom part of the form shall be completed according to the instructions provided within this section and according to the sequence provided in Section 5.2.1. The depth column refers to the depth below ground surface and should be provided in feet. The tick marks can be arbitrarily set to any depth interval depending on the scale needed except where client requirements dictate the spacing. The lithology column should contain a schematic representation of the subsurface according to the symbols found in Attachment G. Use a single X to mark the area where no core was recovered, and notes should be recorded as to why the section was not recovered. The X should be marked from the top to the bottom of the section so that the entire interval is marked. If the geologist can interpret the probable lithology of the missing section with reasonable confidence, they may fill in the symbols behind the X. Sharp or abrupt contacts between lithologies will be indicated by a solid horizontal line.

Gradational changes in lithologic composition will be shown by a gradual change of lithologic symbol in the appropriate zone. PID/FID hits should be recorded within the PID/FID column at the appropriate depth, if applicable. Blow counts specifically refer to the number of hammer blows it takes to drive a split-spoon into the ground. Usually this is recorded as the number of blows per 6 inches but may vary. The recording of blow counts provides a relative feel for the cohesiveness of the formation. The individual recording lithologic logs should ask the FTL whether it is required information. The description column is the most important part of the Lithologic Log Form and is where the lithology is described. In completing this section, use the applicable reference charts and complete according to the sequence in Section 5.2.1. The sample interval column is reserved for noting any samples taken and processed for the laboratory. The sample number shall be filled in at the appropriate depth. The last column refers to the percent core recovery. The individual performing lithologic logging should determine the amount recovered and write the percentage at the appropriate depth.

In addition to the information on the lithologic form, the logger should fill in appropriate information into the logbook when there is a rig shutdown, rig problems, failures to recover cores, or other issues.

## 5.2 General Guidelines for Using and Supplementing Lithologic Descriptive Protocols

This SOP is intended to serve as a guide for recording basic lithologic information with emphasis on those sediment or rock properties that affect groundwater flow and contaminant transport. The fields of specialization of geologists using this SOP will vary. If the user has expertise in a particular field of petrology or soil science that allows for descriptions of certain geologic sections beyond the basic level required by this SOP, they may expand their descriptions. This should be done only with approval of the FTL. The descriptive protocol presented here must be followed in making basic observations. Any further descriptions must follow a protocol that is published and generally recognized by the geologic community as a standard reference. General lithologic description will not include collecting detailed information such as can be obtained from sieve analysis or petrographic analysis. This SOP is a guide for recording visual observations of samples in the field aided by a 10x hand lens and the other simple tools. Field descriptions should be supplemented by petrographic analysis and sieve analysis when the FTL needs data on numerical grain-size distributions, secondary porosity development, or other data that can be collected by these methods.

This SOP includes protocols for describing igneous, metamorphic, sedimentary rocks, and unconsolidated materials. Common abbreviations are given in Attachment H. This SOP includes charts to be used for classification and naming of rocks, sediments, and soils and descriptions of texture, sedimentary structures, and percentage composition of grains. There is also a chart of lithologic symbols to be used and a list of abbreviations. For charts covering other observations or field procedures not specified by this SOP, the user is referred to the following for more information:

- *Compton's Manual of Field Geology* and *American Geological Society (AGI) Data Sheets for Geology in the Field, Laboratory, and Office* contain other reference charts applicable to descriptions. The source of the chart used must be recorded on the Lithologic Log Form or in the field logbook.

- The Munsell soil color chart may be used for descriptions of color.

- The *Dictionary of Geological Terms* (AGI) is to be used for definitions of geological terms.

Some observations will be common to all rock and soil descriptions. All descriptions should include as appropriate: name of sediment or rock, color, sedimentary structures, texture, moisture content, composition, fabric, significant inclusions, and degree of consolidation or induration. The description of each category should be separated by a semicolon. Each section that discusses descriptions of a particular lithology provides a sequence for recording observations. Follow these sequences for all descriptions. All lithologic descriptions shall be segregated from interpretive comments by recording them in the field book.

Secondary features affecting porosity and permeability such as fractures (joints or faults), cavities, and/or bioturbation should be described if observed. Exact measurement of apparent bed thicknesses should be made when logging core and should supplement terminology such as "thin" or "thick." Particular attention is to be given to recording exact locations of water tables, perched saturated zones, and description of contaminants that may be visible.

In some cases individuals logging may wish to describe materials such as unconsolidated sediments and soils according to different systems such as the USCS or USDA Soil Taxonomy System. These descriptions can provide additional information from what is required by this SOP. If an individual is competent in using other description methods, then they should do so with permission from the FTL.

It is often more practical to use abbreviations for often repeated terminology when recording lithologic descriptions. For the terms given in this SOP, its attachments, or the associated charts to be used for description in the field, use only the designated abbreviations. Other abbreviations are allowed; however, the abbreviation and its meaning should be recorded on the lithologic log the first time it is used and should be recorded at least once for every well or boring log. Loggers are cautioned to limit the use of abbreviations to avoid producing a lithologic log that is excessively cryptic.

### 5.2.1 Protocols for Lithologic Description

This section describes the protocols for completing a lithologic description. The logger should use the appropriate portion of this section when describing cores. In recording descriptions of sedimentary sections from a whole core, it is possible to reduce the amount of description being written by at least two strategies. One is to look at as long of a section of core as possible, looking for the "big" picture. For instance, in a 20-foot-thick zone, the dominant lithology may be siltstone that is interrupted by several thin beds of another lithology such as gravel. This section description can be simplified by writing: 35-55 below ground surface (bgs) = siltstone (with other descriptors) except as noted; 37.5-38.5 gravel zone (with descriptors); 40-42 pebble zone (with descriptors); etc. This also aids in "seeing" the thickest unit designations possible for use in modeling. Another acceptable way to describe the same interval would be: 35-37.5 siltstone; 37.5-38.5 gravel zone (with descriptors); 38-40 same as 35-37.5; 40-42 pebble zone (with descriptors); etc.

**Description of Unconsolidated Material**

Unconsolidated material comprises a significant portion of the sections of interest at CDM sites. The shallow subsurface is very important to the hydrologic investigation, as this is the portion of the geologic section where infiltration first occurs. Much of the contamination at sites being investigated is surface contamination and therefore lies on, or within, the upper portion of the surficial material.

For the purpose of this SOP, soil refers to the upper biochemically weathered portion of the regolith and not the entire regolith itself. Soils are to be described as unconsolidated material and should use the same description format. The scientist may use the USCS classification if consistent with project objectives (Attachment K). More detailed soil descriptions should only be made in addition to descriptions outlined below.

**Descriptions of unconsolidated sediments should follow the following sequence:**

- Name of sediment (sand, silt, clay, etc.)
- Texture
- Composition of larger-grained sediments
- Color
- Structure
- Degree of consolidation and cementation
- Moisture content
- Evidence of bioturbation
- Description of contacts

In naming unconsolidated material (refer to Attachment I - Naming of Unconsolidated Materials), the particle size with the highest percentage is the root name. When additional grains are present in excess of 15 percent, the root name is modified by adding a term in front of the root name. For instance, if a material is 80 percent sand and 20 percent gravel, then it is gravelly sand. If the subordinate grains comprise less than 15 percent but greater than 5 percent, the name is written: ____________________(dominant grain) with ________________(subordinate grain). For example, a sediment with 90 percent sand and 10 percent silt would be named a sand with silt. If a sediment contains greater than 15 percent of four particle sizes, then the name is comprised of the dominant grain size as the root name and modifiers as added before. For example, if a material is 60 percent sand, 20 percent silt and 20 percent clay the name would be a silty clayey sand. If a material is 70 percent sand, 20 percent silt and 10 percent clay, it would be a silty sand with clay. When large cobbles or boulders are present, their percentage should be estimated and their mineralogy recorded. Use AGI Data Sheet 29.1 (Attachment B) for grain terms. Refer to Attachment J for an example sorting chart.

**Description of Sedimentary Rocks**
Sedimentary rocks consist of lithified detrital sediments such as sand and clay, chemically precipitated sediments such as limestone and gypsum, and biogenic material such as coal and coquina. The classification scheme for naming these rocks is found in Attachment E - Classification of Sedimentary Rocks.

**Descriptions for sedimentary rocks should be given in the lithologic log in the following sequence:**

- Name of rock
- Texture
- Color
- Sedimentary structures
- Degree of composition
- Presence of fractures or vugs
- Moisture content
- Bioturbation
- Description of contacts

**Description of Igneous and Metamorphic Rocks**
Igneous rocks, volcanic and plutonic, and metamorphic rocks are not as commonly observed at work sites, but they may be found interspersed in the sedimentary section as ash layers and as bedrock. Where they form bedrock, the development of fractures and vugs is important to their hydrologic properties. If the logger is unsure of the name of the rock because of difficulty in determining mineralogy, the name shall be accompanied by a question mark. Attachments D and F provide a classification system for these materials.

**Igneous and metamorphic rock descriptions should follow the general format:**

- Name of rock
- Texture
- Color
- Degree of induration for volcaniclastics
- Composition
- Presence of fractures or vugs
- Presence of secondary mineralization
- Moisture content
- Weathering

## 6.0 Restrictions/Limitations

Only geologists, or similarly qualified persons trained in lithologic description, are qualified to perform the duties described in this SOP. The FTL for a project will have the authority to decide whether or not an individual is qualified.

## 7.0 References

American Geological Society, *American Geological Society Data Sheets for Geology in the Field*, Laboratory, and Office, 3rd Ed, 1989.

American Geological Society, *Dictionary of Geologic Terms*, Anchor Press, Garden City, New York, 1960.

Compton, R.R., *Manual of Field Geology*, John Wiley & Sons Inc., New York, New York, 1962.

*Munsell Color Chart*, Soil Test Inc., Evanston, Illinois, 1975.

U.S. Department of Agriculture Soil Conservation Service, *Soil Taxonomy*, U.S. Government Printing Office, Washington, D.C., 1972.

Woodward, L.A., *Laboratory Manual Physical Geology*, University of New Mexico Printing, Albuquerque, New Mexico, 1988.

## 8.0 Attachments

**Note**: These Attachments are for informational purposes. Other equivalent charts such as USCS or logs may be used.

Attachment A - CDM Federal Programs Corporation Lithologic Log

Attachment B - Grain-Size Scale; Graph determining size of sedimentary particles, particle degree of roundness charts

Attachment C - Comparison Chart for Estimating Percentage Composition

Attachment D - Classification of Igneous Rocks

Attachment E - Classification of Sedimentary Rocks

Attachment F - Classification of Metamorphic Rocks

Attachment G - Lithologic Symbol Chart

Attachment H - Common Abbreviations

Attachment I - Naming of Unconsolidated Materials

Attachment J - Sorting Chart

Attachment K - Example of Unified Soil Classification System (USCS)

## Attachment A

| **CDM Federal Programs Corporation<br>Lithologic Log** | | |
|---|---|---|
| Boring No. __________________ | | Sheet _____ of _____ |
| Project: | Project No.: | Date Started: |
| Well No.: | Rig: | Date Ended: |
| Logged By: | Total Depth: | Driller: |
| Weather: | | Bits: |

| **Depth** | **Lithology** | **Sample Interval** | **% Recovery** | **PID/ FID** | **Blow Counts** | **Description** |
|---|---|---|---|---|---|---|
| | | | | | | |
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| **Proportions** | | **Cohesionless** | | **Cohesive Consistency** | |
|---|---|---|---|---|---|
| | | Blows | | Blows | |
| trace | 0 to 10% | loose | 0 to 10 | 0-4 | soft |
| little | 10 to 20% | med dens | 10 to 30 | 4-8 | med stiff |
| some | 20 to 35% | dense | 30 to 50 | 8-15 | stiff |
| and | 35 to 50% | very dense | 50+ | 15-30 | very stiff |
| | | | | 30+ | hard |

## Attachment B

AGI DATA SHEET 29.1

### Grain-size Scales

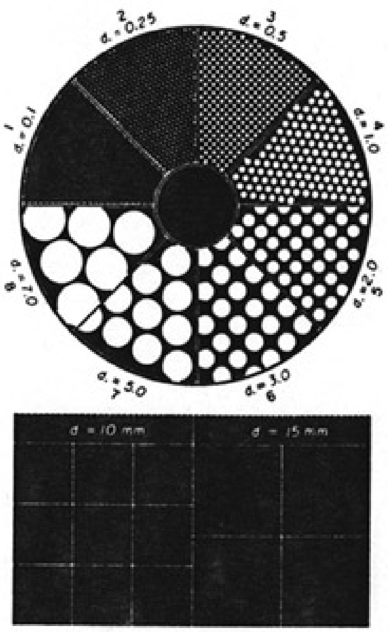
By Roy L. Ingram, University of North Carolina

GRAIN-SIZE SCALE USED BY AMERICAN GEOLOGISTS
Modified Wentworth Scale — after Lane, et al., 1947, Trans. American Geophysical Union, v. 28, p. 936-938

| phi | GRADE LIMITS mm | mm | inches | U.S. Standard Sieve Series | GRADE NAME | | |
|---|---|---|---|---|---|---|---|
| −12 | 4096 | | 161.3 | | | | |
| | | | | | very large | | |
| −11 | 2048 | | 80.6 | | | | |
| | | | | | large | | |
| −10 | 1024 | | 40.3 | | | Boulders | |
| | | | | | medium | | |
| −9 | 512 | | 20.2 | | | | |
| | | | | | small | | |
| −8 | 256 | | 10.1 | | | | |
| | | | | | large | | |
| −7 | 128 | | 5.0 | | | Cobbles | |
| | | | | | small | | GRAVEL |
| −6 | 64 | | 2.52 | 63 mm | | | |
| | | | | | very coarse | | |
| −5 | 32 | | 1.26 | 31.5 mm | | | |
| | | | | | coarse | | |
| −4 | 16 | | 0.63 | 16 mm | | | |
| | | | | | medium | Pebbles | |
| −3 | 8 | | 0.32 | 8 mm | | | |
| | | | | | fine | | |
| −2 | 4 | | 0.16 | No. 5 | | | |
| | | | | | very fine | | |
| −1 | 2 | | 0.08 | No. 10 | | | |
| | | | | | very coarse | | |
| 0 | 1 | | 0.04 | No. 18 | | | |
| | | | | | coarse | | |
| +1 | 1/2 | 0.500 | | No. 35 | | | |
| | | | | | medium | Sand | SAND |
| +2 | 1/4 | 0.250 | | No. 60 | | | |
| | | | | | fine | | |
| +3 | 1/8 | 0.125 | | No. 120 | | | |
| | | | | | very fine | | |
| +4 | 1/16 | 0.062 | | No. 230 | | | |
| | | | | | coarse | | |
| +5 | 1/32 | 0.031 | | | | | |
| | | | | | medium | | |
| +6 | 1/64 | 0.016 | | | | Silt | |
| | | | | | fine | | |
| +7 | 1/128 | 0.008 | | | | | |
| | | | | | very fine | | |
| +8 | 1/256 | 0.004 | | | | | MUD |
| | | | | | coarse | | |
| +9 | 1/512 | 0.002 | | | | | |
| | | | | | medium | | |
| +10 | 1/1024 | 0.001 | | | | Clay size | |
| | | | | | fine | | |
| +11 | 1/2048 | 0.0005 | | | | | |
| | | | | | very fine | | |
| +12 | 1/4096 | 0.00025 | | | | | |

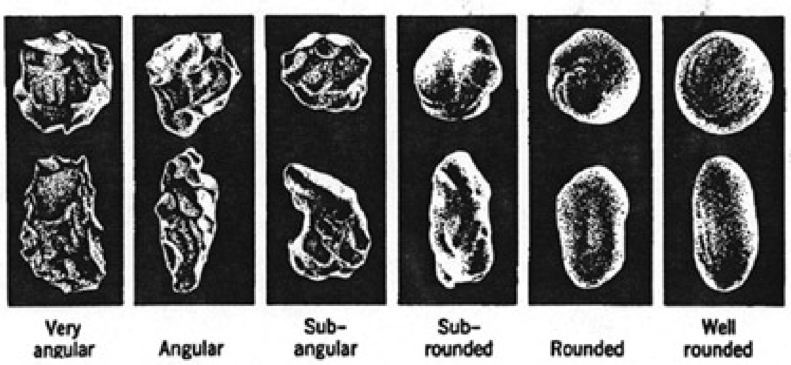
AGI DATA SHEET 28.2

LIGHT PARTICLES



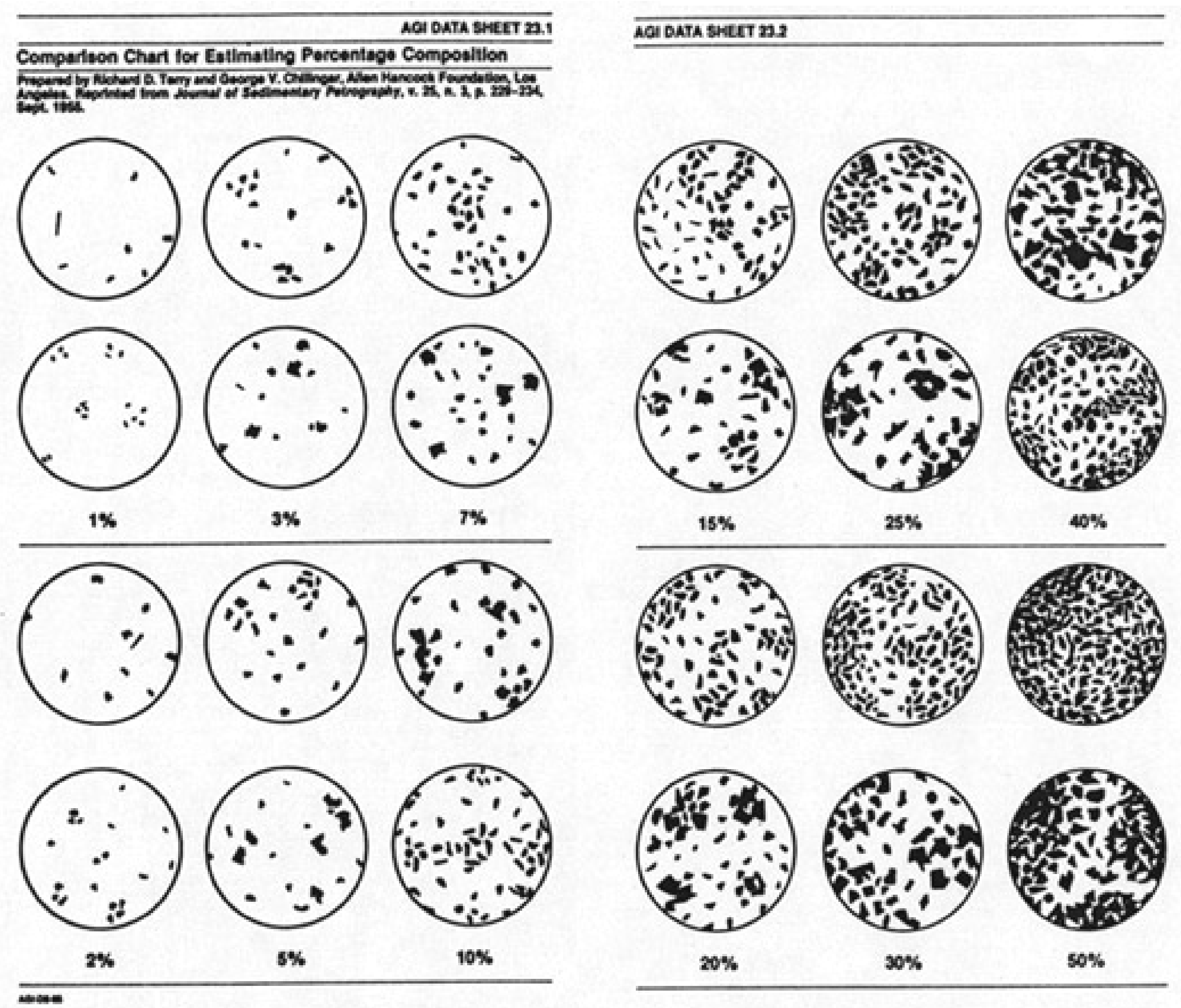

References: (1) George V. Chilingar, 1956, Soviet classification of sedimentary particles and Vasil'evskiy graph: AAPG Bull., v. 40, no. 7, p. 1714. (2) M.S. Shvetsov, 1948, Petrography of sedimentary rocks, 2nd ed., 387 p. Gosgeolizdat, Moscow-Leningrad

American Geological Institute, Data Sheets, Third Edition, 1989.




Compton, R.R., Manual of Field Geology, 1962.

## Attachment C




American Geological Institute, Data Sheets, Third Edition, 1989.

## Attachment D

| Classification of Igneous Rocks | | | | | |
|---|---|---|---|---|---|
| **Mineral Composition** | | | | | |
| | | Quartz >10%<br>Abundant feldspar<br>Mafic minerals minor | Quartz <10%<br>Abundant feldspar<br>Mafic minerals moderate | Feldspar abundant<br>Mafic<br>Minerals 40-70%;<br>Quartz minor or absent | Mafic minerals >70% |
| Color Index | | Light Color | Intermediate color | Dark | Dark |
| Chemistry | | $SiO_2$ 70% | $SiO_2$ 60% | $SiO_2$ 50% | $SiO_2$ 40% |
| | Phaneritic (visible with naked eye) | Granite (Gr) | Diorite (Dr) | Gabbro (Gb) | Peridotite (Pr)<br>(mostly olivine) |
| TEXTURE | Aphanitic (microscopic) | Rhyolite (Ry)<br>(quartz phenocrysts) | Andesite (An)<br>(feldspar or mafic phenocrysts; no quartz) | Basalt (Ba) | Komatiite (Km)<br>(very rare) |
| | | Felsite (Fl)<br>(no phenocrysts) | | | |
| | Glassy | Obsidian (ob) Pumice (Pu) | | Rare | |
| | Glassy-Fragmental (Pyroclastic) | Tuff <4mm (Tf)<br>Breccia >4mm (Br) | | Rare | |

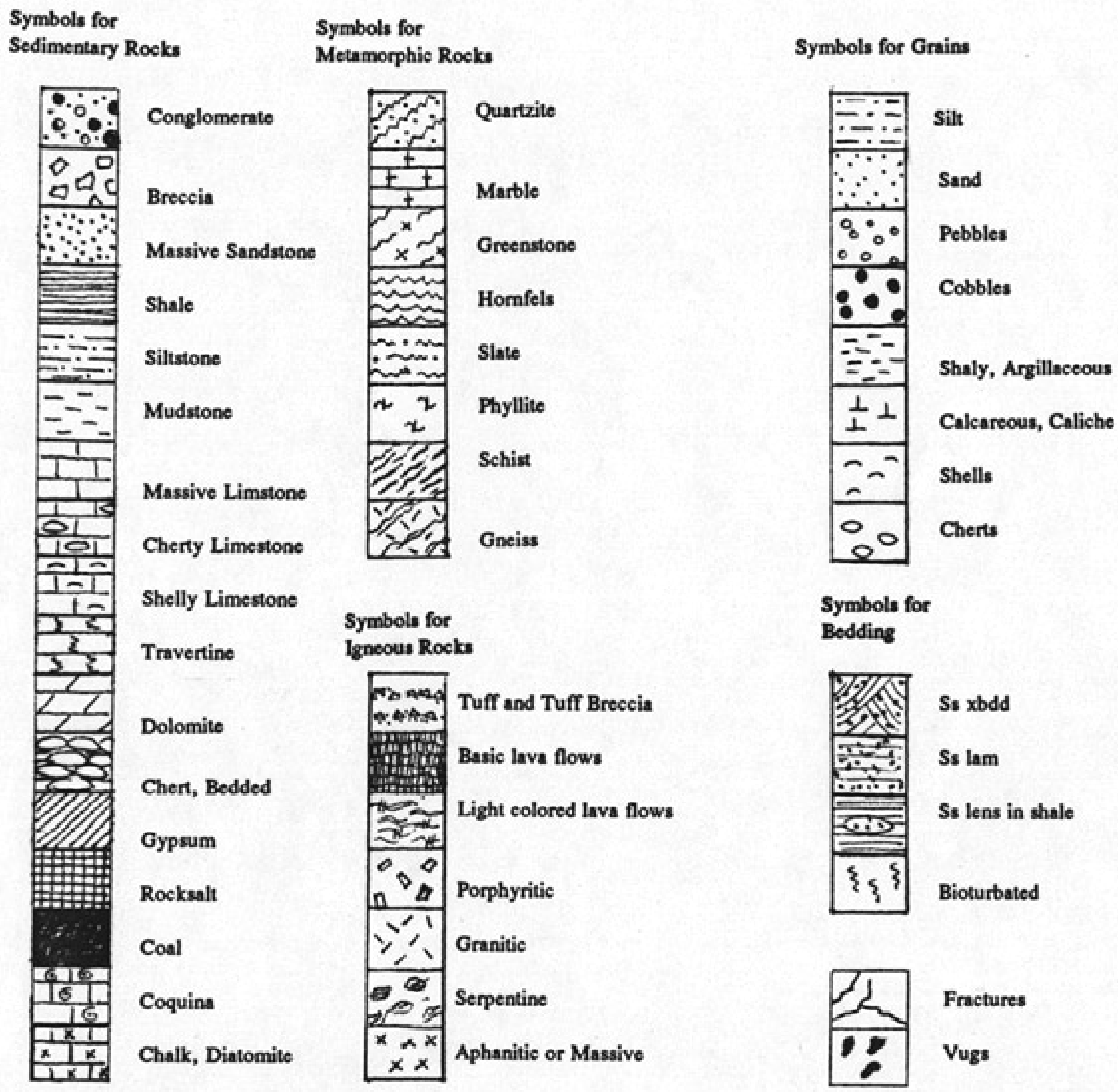
## Attachment E

| Classification of Sedimentary Rocks | | | | |
|---|---|---|---|---|
| ***Detrital*** | ***Detrital Classification*** | ***Principal Composition*** | ***Additional Identifying Characteristics*** | ***Name of Rock*** |
| | Rudaceous (clast diameter > 2 mm) | Gravel | Rounded Clasts | Conglomerate (Cg) |
| | | | Angular Clasts | Breccia (Br) |
| | Arenaceous (clast diameter between 0.0625 mm [1/16 mm] and 2 mm) | Sand | Mineral composition and detrital matrix content varies. Additional detrital matrix qualifiers (arenite or wacke) and mineral composition qualifiers (quartz, arkose, feldspathic, etc.) may be necessary. | Sandstone (Sa) |
| | Argillaceous (clast diameter <0.0625 mm) | Mud | Non-fissile along bedding planes, silt predominant over clay | Siltstone (Sls) |
| | | | Non-fissile along bedding planes, clay predominant over silt | Claystone |
| | | | Non-fissile along bedding planes, silt and clay fraction approximately equal or unknown | Mudstone (Ms) |
| | | | Fissile along bedding planes | Shale (Shl) |
| ***Chemical*** | ***Chemical Classification*** | ***Principal Composition*** | ***Additional Identifying Characteristics*** | ***Name of Rock*** |
| | Calcareous | Calcite (Calcium Carbonate) | Effervesces on contact with dilute HCl | Limestone (La) |
| | | Dolomite (Calcium Magnesium Carbonate) | Pulverized sample effervesces on contact with dilute HCL | Dolomite (Dl), Dolostone |
| | Siliceous | Quartz (Silicon Dioxide) | Hard, dense, fractures conchoidally | Chert (Ch) |
| | Evaporites | Hydrated Calcium Sulfate | Earthy and crumbly | Gypsum (Gy) |
| | | Calcium Sulfate | Usually exhibits indistinct stratification | Anhydrite |
| | | Halite (Sodium Chloride) | Cubic cleavage | Rock Salt (Na) |
| ***Organic (Organogenetic or Biochemical)*** | ***Chemical Classification*** | ***Principal Composition*** | ***Additional Identifying Characteristics*** | ***Name of Rock*** |
| | Calcareous | Fossil shells and fragments | Loosely cemented fragmental limestone | Coquina (Cq) |
| | | Foraminiferal shells | Soft, micritic limestone | Chalk (Chk) |
| | | Calcite or aragonite | Derived from evaporation of spring water | Travertine (Tvr) |
| | Siliceous | Diatom shells (saltwater or freshwater organisms) | Light-colored, soft, friable, and porous siliceous deposit | Diatomite (Dm) |
| | Carbonaceous | Plant Remains | Degree of lithification varies-additional qualifiers such as peat, lignite, bituminous and anthracite may be necessary. | Coal (Cl) |

## Attachment F

<table>
<tr><th colspan="4">Classification of Metamorphic Rocks</th></tr>
<tr><th>Structure</th><th>Texture</th><th>Chief Minerals</th><th>Name</th></tr>
<tr><td rowspan="4">Non foliate</td><td>granular; breaks across grains</td><td>quartz</td><td>Quartzite (Qzt)</td></tr>
<tr><td>granular; grains clearly visible</td><td>calcite</td><td>Marble (Mbl)</td></tr>
<tr><td>granular; grains altered and indistinct</td><td>plagioclase, chlorite, epidote hornblende</td><td>Greenstone (Grs)</td></tr>
<tr><td>very fine-grained</td><td>indistinguishable; mostly submicroscopic micas and clays</td><td>Hornfels (Hnf)</td></tr>
<tr><td rowspan="12">Foliate</td><td>slaty</td><td>submicroscopic mica, quartz</td><td>Slate (Slt)</td></tr>
<tr><td>phyllitic</td><td>microscopic mica, quartz</td><td>Phyllite (Pyl)</td></tr>
<tr><td rowspan="7">schistose</td><td>microscopic mica, quartz, amphibole</td><td>Blueschist</td></tr>
<tr><td>chlorite, mica plagioclase</td><td>chlorite schist (CL-Sch)</td></tr>
<tr><td>muscovite, quartz</td><td>Muscovite (Ms) Schist (Sch)</td></tr>
<tr><td>garnet, muscovite</td><td>Garnet (G) Muscovite (Ms) Schist (Sch)</td></tr>
<tr><td>hornblende, plagioclase</td><td>Amphibolite (Amp)</td></tr>
<tr><td>staurolite, garnet, muscovite</td><td>Garnet (G) Staurolite (S) Muscovite (Ms) Schist (Sch)</td></tr>
<tr><td>plagioclase, hornblende</td><td>Amphibolite (Amp) Gneiss (Gns)</td></tr>
<tr><td rowspan="3">gneissose</td><td>feldspar, quartz</td><td>Granitie (Gr) Gneiss (Gns)</td></tr>
<tr><td>eye-shaped feldspar, mica</td><td>Augen (Au) Gneiss (Gns)</td></tr>
</table>

## Attachment G




Compton, R.R., Manual of Field Geology, 1962.

## Attachment H

| Common Abbreviations | | |
|---|---|---|
| Abundant - abnt | Diameter – dia | Laminated – lam |
| Amount – amt | Different – diff | Maximum – max |
| Approximate – approx | Disseminated – dissem | Pebble – pbl |
| Arenaceous – aren | Elevation – elev | Phenocryst – phen |
| Argillaceous – arg | Equivalent – equiv | Porphyritic – proph |
| Average – ave | foliated – fol | Probable – prob |
| Bedded – bdd | Formation frm | Quartz – qrz |
| Bedding – bdg | Fracture – frac | Regular – reg |
| Calcareous – calc | Fragmental – frag | Rocks – rx |
| Cemented – cmt | Granular – Gran | Rounded – rnd |
| Cobble – cbl | Gypsiferous – Gyp | Saturated – sat |
| Contact – ctc | Horizontal – hriz | Secondary – sec |
| Cross-bedded - xbdd | Igneous – ign | Siliceous – sil |
| Cross-bedding – xbdg | Inclusion – incl | Structure – struc |
| Cross-laminated – xlam | Interbedded – intbdd | Unconformity – uncnf |
| Crystal – xl | Irregular – ireg | Variegated – vrgt |
| Crystalline – xln | Joint – jnt | Vein – vn |
| | | |
| **Grain Size** | **Contacts** | **Sorting** |
| grain – gn | gradational – grad | poor – pr |
| fine – f | erosional – er | moderate – mod |
| very fine – vf | abrupt – ab | well – well |
| medium – med | | |
| coarse – crs | **Fabric** | |
| large – lg | grain supported – gs | |
| very large – vlg | matrix supported – ms | |
| small – sm | imbricate – im | |

Adapted from, Compton, R.R., *Manual of Field Geology*, 1962.

## Attachment I

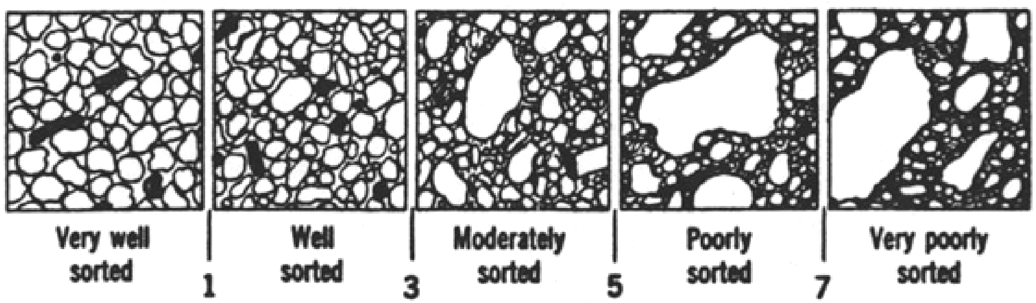
## Naming of Unconsolidated Materials

| Main Particle | Gravel | Sand | Silt | Clay |
|---|---|---|---|---|
| > 15 % gravel | Gravel | Gravelly Sand | Gravelly Silt | Gravelly Clay |
| > 15 % sand | Sandy Gravel | Sand | Sandy Silt | Sandy clay |
| > 15 % silt | Silty Gravel | Silty Sand | Silt | Silty Clay |
| > 15 % clay | Clayey Gravel | Clayey Sand | Clayey Silt | Clay |
| 5-15 % gravel | Not Applicable | Sand with Gravel | Silt with Gravel | Clay with Gravel |
| 5-15 % sand | Gravel with sand | Not applicable | Silt with Sand | Clay with sand |
| 5-15 % silt | Gravel with silt | Sand with silt | Not applicable | Clay with silt |
| 5-15 % clay | Gravel with clay | Sand with clay | Silt with clay | Not applicable |
| > 15% gravel plus 15% sand | Sandy Gravel | Gravelly Sand | Gravelly Sandy Silt | Gravelly Sandy Clay |
| > 15% gravel plus 15% silt | Silty Gravel | Gravelly Silty Sand | Gravelly Silt | Gravelly Silty Clay |
| > 15% gravel plus 15% clay | Clayey Gravel | Gravelly Clayey Sand | Gravelly Sandy Silt | Gravelly Clay |
| > 15% sand plus 15% silt | Silty Sand Gravel | Silty Sand | Sandy Silt | Sandy Silty Clay |
| > 15% sand plus 15% clay | Sandy Clayey Gravel | Clayey Sand | Sandy Clayey Silt | Sandy Clay |
| > 15% silt plus 15% clay | Silty Clayey Gravel | Silty Clayey Sand | Clayey Silt | Silty Clay |
| **Note**: Other combinations are possible when all particle sizes are present in greater than 15%. For example, a Silty Clayey Gravelly Sand. Other possible combinations exist such as a Gravelly Sand with silt. | | | | |

Compton, R.R., *Manual of Field Geology*, 1962.

**Attachment J**

**Sorting Chart**

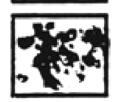



Compton, R.R., Manual of Field Geology, 1962.

**Attachment K**

**Example of Unified Soil Classification System (USCS)**

Unified Soil Classification System (USCS)

| | MILLIMETERS | INCHES | SIEVE SIZES |
|---|---|---|---|
| BOULDERS | > 300 | > 11.8 | - |
| COBBLES | 75 - 300 | 2.9 - 11.8 | - |
| GRAVEL: COARSE | 75 - 19 | 2.9 - .75 | - |
| FINE | 19 - 4.8 | .75 - .19 | 3/4" - No. 4 |
| SAND: COARSE | 4.8 - 2.0 | .19 - .08 | No. 4 - No. 10  |
| MEDIUM | 2.0 - .43 | .08 - .02 | No. 10 - No. 40  |
| FINE | .43 - .08 | .02 - .003 | No. 40 - No. 200  |
| FINES: SILTS | < .08 | < .003 | < No. 200  |
| CLAYS | < .08 | < .003 | < No. 200 |

## Attachment K

## Example of Unified Soil Classification System (USCS) (Continued)

### CLAY

| CLAY CONSISTENCY | THUMB PENETRATION | SPT, N BLOWS/ FT. | Undrained Shear Strength c (PSF) TORVANE | Unconfined Compressive Strength $q_u$ Pocket Penetrometer |
|---|---|---|---|---|
| VERY SOFT | Easily penetrated several inches by thumb. Exudes between thumb and finger's when squeezed in hand. | < 2 | 250 | 500 |
| SOFT | Easily penetrated one inch by thumb. Molded by light finger pressure. | 2 - 4 | 250 - 500 | 500 - 1000 |
| MEDIUM STIFF | Can be penetrated over 1/4 " by thumb with moderate effort. Molded by strong finger pressure. | 4 - 8 | 500 - 1000 | 1000 - 2000 |
| STIFF | Indented about 1/4" by thumb but penetrated only with great effort. | 8 - 15 | 1000 - 2000 | 2000 - 4000 |
| VERY STIFF | Readily indented by thumbnail. | 15 - 30 | 2000 - 4000 | 4000 - 8000 |
| HARD | Indented with difficulty by thumbnail. | > 30 | > 4000 | > 8000 |

### SAND

| SOILTYPE | SPT, N Blows/ft. | Relative Density,% | FIELD TEST |
|---|---|---|---|
| VERY LOOSE SAND | 4 | 0 - 15 | Easily penetrated with 1/2" reinforcing rod pushed by hand. |
| LOOSE SAND | 4 - 10 | 15 - 35 | Easily penetrated with 1/2" reinforcing rod pushed by hand. |
| MEDIUM DENSE SAND | 10 - 30 | 35 - 65 | Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer. |
| DENSE SAND | 30 - 50 | 65 - 85 | Penetrated a foot with 1/2" reinforcing rod driven with 5-lb hammer. |
| VERY DENSE SAND | 50 | 85 - 100 | Penetrated only a few inches with 1/2" reinforcing rod driven with 5-lb hammer. |

## Summary of USCS Field Identification Tests

<table>
<tr><td rowspan="8">Coarse-Grained Soils<br>More than half the material (by weight) is individual grains visible to the naked eye</td><td colspan="2" rowspan="4">Gravelly Soils<br>More than half of coarse fraction is larger than 4.75 mm</td><td rowspan="2">Clean Gravels<br>Will not leave a stain on a wet palm</td><td colspan="3">Substantial amounts of all grain particle sizes</td><td>GW</td></tr>
<tr><td colspan="3">Predominantly one size or range of sizes with some intermediate sizes missing</td><td>GP</td></tr>
<tr><td rowspan="2">Dirty Gravels<br>Will leave a stain on a wet palm</td><td colspan="3">Non-plastic fines (to identify, see ML below)</td><td>GM</td></tr>
<tr><td colspan="3">Plastic fines (to identify, see CL below)</td><td>GC</td></tr>
<tr><td colspan="2" rowspan="4">Sandy Soils<br>More than half of coarse fraction is smaller than 4.75 mm</td><td rowspan="2">Clean Sands<br>Will not leave a stain on a wet palm</td><td colspan="3">Wide range in grain size and substantial amounts of all grain particle sizes.</td><td>SW</td></tr>
<tr><td colspan="3">Predominantly one size or a range of sizes with some intermediate sizes missing</td><td>SP</td></tr>
<tr><td rowspan="2">Dirty Sands<br>Will leave a stain on a wet palm</td><td colspan="3">Non-plastic fines (to identify, see ML below)</td><td>SM</td></tr>
<tr><td colspan="3">Plastic fines (to identify, see CL below)</td><td>SC</td></tr>
<tr><td rowspan="5">Fine-Grained Soils<br>More than half the material (by weight) is individual grains not visible to the naked eye<br><br>(<0.074 mm)</td><td>Ribbon</td><td>Liquid Limit</td><td>Dry Crushing Strength</td><td>Dilatancy Reaction</td><td>Toughness</td><td>Stickiness</td><td></td></tr>
<tr><td>None</td><td><50</td><td>None to Slight</td><td>Rapid</td><td>Low</td><td>None</td><td>ML</td></tr>
<tr><td>Weak</td><td><50</td><td>Medium to High</td><td>None to Very Slow</td><td>Medium to High</td><td>Medium</td><td>CL</td></tr>
<tr><td>Strong</td><td>>50</td><td>Slight to Medium</td><td>Slow to None</td><td>Medium</td><td>Low</td><td>MH</td></tr>
<tr><td>Very Strong</td><td>>50</td><td>High to Very High</td><td>None</td><td>High</td><td>Very High</td><td>CH</td></tr>
<tr><td>Highly Organic Soils</td><td colspan="6">Readily identified by color, odor, spongy feel, and frequently by fibrous texture</td><td>OL<br>OH<br>Pt</td></tr>
</table>

# Field Logbook Content and Control

Prepared: Del Baird

Technical Review: Sharon Budney

QA Review: Douglas J. Updike

Approved: Michael C. Malloy 2/24/04
Signature/Date

Issued: 2/18/04
Signature/Date

## 1.0 Objective

The objective of this standard operating procedure (SOP) is to set CDM Federal (CDM) criteria for content entry and form of field logbooks. Field logbooks are an essential tool to document field activities for historical and legal purposes.

## 2.0 Background

### 2.1 Definitions

**Biota** - The flora and fauna of a region.

**Magnetic Declination Corrections** - Compass adjustments to correct for the angle between magnetic north and geographical meridians.

### 2.2 Discussion

Information recorded in field logbooks includes field team names, observations, data, calculations, date/time, weather, and description of the data collection activity, methods, instruments, and results. Additionally, the logbook may contain deviations from plans and descriptions of wastes, biota, geologic material, and site features including sketches, maps, or drawings as appropriate.

## 3.0 Responsibilities

**Field Team Leader (FTL)** - The FTL is responsible for ensuring that the format and content of data entries are in accordance with this procedure.

**Site Personnel** - All CDM employees who make entries in field logbooks during onsite activities are required to read this procedure prior to engaging in this activity. The FTL will assign field logbooks to site personnel who will be responsible for their care and maintenance. Site personnel will return field logbooks to the records file at the end of the assignment.

## 4.0 Required Equipment

- Site-specific plans
- Field notebook
- Indelible black or blue ink pen
- Ruler or similar scale

# 5.0 Procedures

## 5.1 Preparation

In addition to this SOP, site personnel responsible for maintaining logbooks must be familiar with all procedures applicable to the field activity being performed. These procedures should be consulted as necessary to obtain specific information about equipment and supplies, health and safety, sample collection, packaging, decontamination, and documentation. These procedures should be located at the field office.

Field logbooks shall be bound with lined, consecutively numbered pages. All pages must be numbered prior to initial use of the logbook. Prior to use in the field, each logbook will be marked with a specific document control number issued by the document control administrator, if required by the contract quality implementation plan (QIP). Not all contracts require document control numbers. The following information shall be recorded on the cover of the logbook:

- Field logbook document control number.
- Activity (if the logbook is to be activity-specific) and location.
- Name of CDM contact and phone number(s).
- Start date.
- In specific cases, special logbooks may be required (e.g., waterproof paper for stormwater monitoring).

The first few (approximately five) pages of the logbook will be reserved for a table of contents (TOC). Mark the first page with the heading and enter the following:

**Table of Contents**

| Date/Description | Page |
|---|---|
| (Start Date)/Reserved for TOC | 1-5 |

The remaining pages of the table of contents will be designated as such with "TOC" written on the top center of each page.

## 5.2 Operation

Requirements that must be followed when using a logbook:

- Record work, observations, quantities of materials, calculations, drawings, and related information directly in the logbook. If data collection forms are specified by an activity-specific plan, this information need not be duplicated in the logbook. However, any forms used to record site information must be referenced in the logbook.
- Do not start a new page until the previous one is full or has been marked with a single diagonal line so that additional entries cannot be made. Use both sides of each page.
- Do not erase or blot out any entry at any time. Indicate any deletion by a single line through the material to be deleted. Initial and date each deletion. Take care to not obliterate what was written previously.
- Do not remove any pages from the book.

Specific requirements for field logbook entries include:

- Initial and date each page.
- Sign and date the final page of entries for each day.
- Initial and date all changes.
- Multiple authors must sign out the logbook by inserting the following:
  Above notes authored by:
  - (Sign name)
  - (Print name)
  - (Date)
- A new author must sign and print his/her name before additional entries are made.
- Draw a diagonal line through the remainder of the final page at the end of the day.
- Record the following information on a daily basis:
  - Date and time
  - Name of individual making entry
  - Names of field team and other persons onsite
  - Description of activity being conducted including station or location (i.e., well, boring, sampling location number) if appropriate
  - Weather conditions (i.e., temperature, cloud cover, precipitation, wind direction, and speed) and other pertinent data
  - Level of personal protection to be used
  - Serial numbers of instruments
  - Required calibration information
  - Serial/tracking numbers on documentation (e.g., carrier air bills)

Entries into the field logbook shall be preceded with the time (written in military units) of the observation. The time should be recorded frequently and at the point of events or measurements that are critical to the activity being logged. All measurements made and samples collected must be recorded unless they are documented by automatic methods (e.g., data logger) or on a separate form required by an operating procedure. In these cases, the logbook must reference the automatic data record or form.

At each station where a sample is collected or an observation or measurement made, a detailed description of the location of the station is required. Use a compass (include a reference to magnetic declination corrections), scale, or nearby survey markers, as appropriate. A sketch of station location may be warranted. All maps or sketches made in the logbook should have descriptions of the features shown and a direction indicator. It is preferred that maps and sketches be oriented so that north is toward the top of the page. Maps, sketches, figures, or data that will not fit on a logbook page should be referenced and attached to the logbook to prevent separation.

Other events and observations that should be recorded include:

- Changes in weather that impact field activities.
- Deviations from procedures outlined in any governing documents. Also record the reason for any noted deviation.
- Problems, downtime, or delays.
- Upgrade or downgrade of personal protection equipment.

### 5.3 Post-Operation

To guard against loss of data due to damage or disappearance of logbooks, completed pages shall be periodically photocopied (weekly, at a minimum) and forwarded to the field or project office. Other field records shall be photocopied and submitted regularly and as promptly as possible to the office. When possible, electronic media such as disks and tapes should be copied and forwarded to the project office.

At the conclusion of each activity or phase of site work, the individual responsible for the logbook will ensure that all entries have been appropriately signed and dated, and that corrections were made properly (single lines drawn through incorrect information, then initialed and dated). The completed logbook shall be submitted to the records file.

## 6.0 Restrictions/Limitations

Field logbooks constitute the official record of onsite technical work, investigations, and data collection activities. Their use, control, and ownership are restricted to activities pertaining to specific field operations carried out by CDM personnel and their subcontractors. They are documents that may be used in court to indicate dates, personnel, procedures, and techniques employed during site activities. Entries made in these logbooks should be factual, clear, precise, and non-subjective. Field logbooks, and entries within, are not to be used for personal use.

## 7.0 References

Sandia National Laboratories, *Procedure for Preparing Sampling and Analysis Plan, Site-Specific Sampling Plan, and Field Operating Procedures*, QA-02-03, Albuquerque Environmental Program Department 3220, Albuquerque, New Mexico, 1991.

Sandia National Laboratories, Division 7723, *Field Operation Procedure for Field Logbook Content and Control, Environmental Restoration Department*, Albuquerque, New Mexico, 1992.

# Photographic Documentation of Field Activities

Prepared: David O. Johnson

Technical Review: Jo Nell Mullins

QA Review: Laura Splichal

Approved: Michael C. Malley 2/24/04
Signature/Date

Issued: 2/18/04
Signature/Date

## 1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide standard guidelines and methods for photographic documentation, which include still and digital photography and videotape recordings of field activities and site features (geologic formations, core sections, lithologic samples, water samples, general site layout, etc.). This document shall provide guidelines designed for use by a professional or amateur photographer. This SOP is intended for circumstances when formal photographic documentation is required. Based on project requirements, it may not be applicable for all photographic activities.

## 2.0 Background

### 2.1 Definitions

**Photographer** – A photographer is the camera operator (professional or amateur) of still photography, including digital photography, or videotape recording whose primary function with regard to this SOP is to produce documentary or data-oriented visual media.

**Identifier Component** – Identifier components are visual components used within a photograph such as visual slates, reference markers, and pointers.

**Standard Reference Marker** – A standard reference marker is a reference marker that is used to indicate a feature size in the photograph and is a standard length of measure, such as a ruler, meter stick, etc. In limited instances, if a ruled marker is not available or its use is not feasible, it can be a common object of known size placed within the visual field and used for scale.

**Slates** – Slates are blank white index cards or paper used to present information pertaining to the subject/procedure being photographed. Letters and numbers on the slate will be bold and written with black, indelible marking pens.

**Arrows and Pointers** – Arrows and pointers are markers/pointers used to indicate and/or draw attention to a special feature within the photograph.

**Contrasting Backgrounds** – Contrasting backgrounds are backdrops used to lay soil samples, cores, or other objects on for clearer viewing and to delineate features.

**Data Recording Camera Back** – A data recording camera back is a camera attachment or built-in feature that will record, at the very least, frame numbers and dates directly on the film.

### 2.2 Discussion

Photographs and videotape recordings made during field investigations are used as an aid in documenting and describing site features, sample collection activities, equipment used, and possible lithologic interpretation. This SOP is designed to illustrate the format and desired placement of identifier components, such as visual slates, standard reference markers, and pointers. These items shall become an integral part of the "visual media" that, for the purpose of this document, shall encompass still photographs, digital photographs, and videotape recordings (or video footage). The use of a photographic logbook and standardized entry procedures are also outlined. These procedures and guidelines will minimize potential ambiguities that may arise when viewing the visual media and ensure the representative nature of the photographic documentation.

### 2.3 Associated Procedures

- CDM Federal SOP 4-1, Field Logbook Content and Control

## 3.0 Responsibilities

**Field Team Leader (FTL)** – The FTL is responsible for ensuring that the format and content of photographic documentation are in accordance with this procedure. The FTL is responsible for directing the photographer to specific situations, site features, or operations that the photographer will be responsible for documenting.

**Photographer** – The photographer shall seek direction from the FTL and regularly discuss the visual documentation requirements and schedule. The photographer is responsible for maintaining a logbook per Sections 5.1, 5.2.4, and 5.3.1 of this SOP.

## 4.0 Required Equipment

The following is a general list of equipment that may be used:

- 35mm camera or disposable single use camera (35mm or panoramic use)
- Digital camera
- Extra batteries for 35mm camera
- Video camera
- Logbook
- Indelible black or blue ink pen
- Standard reference markers
- Slates
- Arrows or pointers
- Contrasting backgrounds
- Medium speed, or multi purpose fine-grain, color, 35 mm negative film or slide film (project dependent)
- Data recording camera back (if available)
- Storage medium for digital camera

## 5.0 Procedures

### 5.1 Documentation

A commercially available, bound logbook will be used to log and document photographic activities. Review the CDM Federal SOP 4-1, Field Logbook Content and Control and prepare all supplies needed for logbook entries.

**Note**: A separate photographic logbook is not required. A portion of the field logbook may be designated as the photographic log and documentation section.

**5.1.1 Field - Health and Safety Considerations**
There are no hazards that an individual will be exposed to specific to photographic documentation. However, site-specific hazards may arise depending on location or operation. Personal protective equipment used in this operation will be site-specific and dictated through requirements set by the site safety officer, site health and safety plan, and/or prescribed by the CDM Federal Corporate Health and Safety Program. The photographer should contact the site safety officer for health and safety orientation prior to commencing field activities. The site health and safety plan must be read prior to entry to the site, and all individuals must sign the appropriate acknowledgement that this has been done.

The photographer should be aware of any potential physical hazards while photographing the subject (e.g., traffic, low overhead hazard, edge of excavation).

## 5.2 Operation

**5.2.1 General Photographic Activities in the Field**
The following sections provide general guidelines that should be followed to visually document field activities and site features using still/digital cameras and video equipment. Listed below are general suggestions that the photographer should consider when performing activities under this SOP:

- The photographer should be prepared to make a variety of shots, from close-up to wide-angle. Many shots will be repetitive in nature or format especially close-up site feature photographs. Consideration should therefore be given to designing a system or technique that will provide a reliable repetition of performance.
- All still film photographs should be made using a medium speed, or multi purpose fine-grain, color negative film in the 35 mm format unless otherwise directed by the FTL.
- It is suggested that Kodak brand "Ektapress Gold Deluxe" film or equivalent be used as the standard film for the still photography requirements of the field activities. This film is stable at room temperature after exposure and will better survive the time lag between exposure and processing. It is suggested that film speed ASA 100 should be used for outdoor photographs in bright sunlight, ASA 200 film should be used in cloudy conditions, and ASA 400 film should be used indoors or for very low-light outdoor photographs.
- No preference of videotape brand or digital storage medium is specified and is left to the discretion of the photographer.
- The lighting for sample and feature photography should be oriented toward a flat condition with little or no shadow. If the ambient lighting conditions are inadequate, the photographer should be prepared to augment the light (perhaps with reflectors or electronic flash) to maintain the desired visual effect.
- Digital cameras have multiple photographic quality settings. A camera that obtains a higher resolution (quality) has a higher number of pixels and will store a fewer number of photographs per digital storage medium.

**5.2.2 General Guidelines for Still Photography**
**Slate Information**
When directed by the FTL, each new roll of film or digital storage medium shall contain on the first usable frame (for film) a slate with consecutively assigned control numbers (a consecutive, unique number that is assigned by the photographer as in sample numbers).

**Caption Information**

All still photographs will have a full caption permanently attached to the back or permanently attached to a photo log sheet. The caption should contain the following information (digital photographs should have a caption added after the photographs are downloaded):

- Film roll control number (if required) and photograph sequence number
- Date and time
- Description of activity/item shown (e.g., name of facility/site, specific project name, project no.)
- Direction (if applicable)
- Photographer

When directed by the FTL, a standard reference marker should be used in all documentary visual media. While the standard reference marker will be predominantly used in close-up feature documentation, inclusion in all scenes should be considered.

Digital media should be downloaded at least once each day.

**Close-Up and Feature Photography**

When directed by the FTL, close-up photographs should include a standard reference marker of appropriate size as an indication of the feature size and contain a slate marked with the site name and any identifying label, such as a well number or core depth, that clearly communicates to the viewer the specific feature being photographed.

Feature samples, core pieces, and other lithologic media should be photographed as soon as possible after they have been removed from their in situ locations. This enables a more accurate record of their initial condition and color. When directed by the FTL, include a standard reference color strip (color chart such as Munsell Soil Color Chart or that available from Eastman Kodak Co.) within the scene. This is to be included for the benefit of the viewer of the photographic document and serves as a reference aid to the viewer for formal lithologic observations and interpretations.

**Site Photography**

Site photography, in general, will consist predominantly of medium and wide-angle shots. A standard reference marker should be placed adjacent to the feature or, when this is not possible, within the same focal plane.

While it is encouraged that a standard reference marker and caption/slate be included in the scene, it is understood that situations will arise that preclude their inclusion within the scene. This will be especially true of wide-angle shots. In such a case, the film/tape control number shall be entered in the photographic logbook along with the frame number and all other information pertinent to the scene.

**Panoramic**

In situations where a wide-angle lens does not provide sufficient subject detail, a single-use disposable panoramic camera is recommended. If this type of camera is not available, a panoramic series of two or three photos would be appropriate. Panoramas can provide greater detail while covering a wide subject, such as an overall shot of a site.

To shoot a panoramic series using a standard 35 mm or digital camera, the following procedure is recommended.

- Use a stable surface or tripod to support the camera
- Allow a 20 to 30 percent overlap while maintaining a uniform horizon
- Complete two to three photos per series

**5.2.3 General Photographic Documentation Using Video Cameras**

As a reminder, it is not within the scope of this document to set appropriate guidelines for presentation or "show" videotape recording. The following guidelines are set for documentary videotape recordings only and should be implemented at the discretion of the FTL.

Documentary videotape recordings of field activities may include an audio slate for all scenes. At the beginning of each video session, an announcer will recite the following information: date, time (in military units), photographer, site ID number, and site location. This oral account may include any additional information clarifying the subject matter being recorded.

A standard reference marker may be used when taking close-up shots of site features with a video camera. The scene may also include a caption/slate. It should be placed adjacent and parallel to the feature being photographed.

It is recommended that a standard reference marker and caption/slate be included in all scenes. The caption information is vital to the value of the documentary visual media and should be included. If it is not included within the scene, it should be placed before the scene.

Original videotape recordings will not be edited. This will maintain the integrity of the information contained on the videotape. If editing is desired, a working copy of the original videotape recording can be made.

A label should be placed on the videotape with the appropriate identifying information (i.e., project name, project number, date, location, etc.).

**5.2.4 Photographic Documentation**

Photographic activities must be documented in a photographic logbook or in a section of the field logbook. The photographer will be responsible for making proper entries.

In addition to following the technical standards for logbook entry as referenced in CDM Federal SOP 4-1, the following information should be maintained in the appropriate logbook:

- Photographer name.
- If required, an entry shall be made for each new roll/tape control number assigned.
- Sequential tracking number for each photograph taken (for digital cameras, the camera-generated number may be used).
- Date and time (military time).
- Location.
- A description of the activity/item photographed.

- If needed, a description of the general setup, including approximate distance between the camera and the subject, may be recorded in the logbook.
- Record as much other information as possible to assist in the identification of the photographic document.

### 5.3 Post Operation
All film will be sent for development and printing to a photographic laboratory (to be determined by the photographer). The photographer will be responsible for arranging transport of the film from the field to the photographic laboratory. The photographer shall also be responsible for arranging delivery of the negatives and photographs, digital storage medium, or videotape to the project management representative.

#### 5.3.1 Documentation
At the end of each day's photographic session, the photographer(s) will ensure that the appropriate logbook has been completely filled out and maintained as outlined in CDM Federal SOP 4-1.

#### 5.3.2 Archive Procedures
1. Photographs and the associated set of uncut negatives, digital media, and original unedited documentary videotape recordings will be submitted to the project files and handled according to contract records requirements. The FTL will ensure their proper distribution.

2. Completed pages of the appropriate logbook will be copied weekly and submitted to the project files.

## 6.0 Restrictions/Limitations
This document is designed to provide a set of guidelines for the field amateur or professional photographer to ensure that an effective and standardized program of visual documentation is maintained.

It is not within the scope of this document to provide instruction in photographic procedures, nor is it within the scope of this document to set guidelines for presentation or "show" photography.

The procedures outlined herein are general by nature. The FTL is responsible for specific operational activity or procedure. Questions concerning specific procedures or requirements should be directed to the FTL.

**Note**: Some sites do not permit photographic documentation. Check with the site contact for any restrictions.

## 7.0 References
U.S. Army Corps of Engineers, *Requirements for the Preparation of Sampling and Analysis Plans, EM 200-1-3*, February 2001, Appendix F.

U.S. Environmental Protection Agency, Region IV, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, Athens, Georgia, November 2001.

U.S. Environmental Protection Agency, National Enforcement Investigations Center, *Multi-Media Investigation Manual*, EPA-330/9-89-003-R, Revised March 1992, p. 85.

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Technical Review: Mark Caldwell

QA Review: James Romig

Approved: Michael C Malley 2/24/04
Signature/Date

Issued: 2/18/04
Signature/Date

## 1.0 Objective

The purpose of this standard operating procedure (SOP) is to define the procedural requirements for well development and purging.

## 2.0 Background

Monitoring wells are developed to repair damage to the formation caused by drilling activities and to settle and remove fines from the filter pack. Wells should not be developed for at least 24 to 48 hours after completion when a cement bentonite grout is used to seal the annular space; however, wells may be developed before grouting if conditions warrant. Wells are purged immediately before groundwater sampling to remove stagnant water and to sample representative groundwater conditions. Wells should be sampled within 3 hours of purging (optimum) to 24 hours after purging (maximum, for low recharge conditions).

### 2.1 Associated Procedures

- CDM Federal SOP 1-6, Water Level Measurement
- CDM Federal SOP 4-5, Field Equipment Decontamination at Non-Radioactive Sites

## 3.0 Responsibilities

**Site Manager** - The site manager is responsible for ensuring that field personnel are trained in the use of this procedure and for verifying that development and purging are carried out in accordance with this procedure.

**Field Team Leader** - The field team leader is responsible for complying with this procedure.

## 4.0 Required Equipment

- Pump, pump tubing, or bailer and rope or wire line
- Power source (e.g., generator), if required
- Water-level meter or weighted surveyor's tape
- Temperature, conductivity, pH, and turbidity meters
- Personal protective equipment as specified in the site-specific health and safety plan
- Decontamination supplies, as required, according to CDM Federal SOP 4-5 Field Equipment Decontamination at Nonradioactive Sites
- Disposal drums, if required
- Photoionization detector (PID) or equivalent as specified in site-specific health and safety plan

# 5.0 Procedures

## 5.1 Well Development

The following steps must be followed when developing wells:

1. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

2. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.

3. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

4. Determine the depth to static water level and depth to bottom of the casing.

5. Prepare the necessary equipment for developing the well. There are a number of techniques that can be used to develop a well. Some of the more common methods are bailing, overpumping, backwashing, mechanical surging, surge and pump, wire brush, swabbing, and high-velocity jetting. All of these procedures are acceptable; however, final approval of the development method rests with the appropriateness of a specific method to the site and the client.

6. For screened intervals longer than 3 meters (m) (10 feet), develop the well in 0.75- or 1-m (2- or 3-foot) intervals from bottom to top. This will ensure proper packing of the filter pack.

7. Continue well development until produced water is clear and free of suspended solids, as determined by a turbidity meter or when pH, conductivity, and temperature have stabilized. Record pertinent data in the field logbook and on appropriate well development forms. Remove the pump assembly or bailers from the well, decontaminate (if required), and clean up the area. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

## 5.2 Volumetric Method of Well Purging

The following steps should be followed when purging a well by the volumetric method:

1. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

2. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.

3. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

4. Determine the depth to static water level and depth to bottom of well casing according to CDM Federal SOP 1-6 Water Level Measurement. Calculate the volume of water within the well bore using the following formula (or equivalent):

$$7.4805 \left[ \frac{D^2\pi}{(4)} \right] dH = \text{volume (in gallons)},$$

where

D = casing diameter in feet. (**Note**: This equation is used for grouted wells with short screens. For wells with long screens and/or ungrouted wells, the D = borehole diameter in feet).

dH = the distance from well bottom to static water level in feet

$\pi = 3.1416$

**Note:** Record all data and calculations in the field logbook.

5. Prepare the pump and tubing, or bailer, and lower it into the casing.

6. Remove the number of well volumes specified in the site-specific plans. Generally, three to five well volumes will be required. Conductivity, pH, and temperature should be measured and recorded, if required by site-specific plans. In low recharge aquifers, the well commonly will be pumped or bailed to dryness before three well volumes of water are removed. If this is the case, there is no need to continue with purging operations. Record pertinent data in the field logbook.

7. Remove the pump assembly or bailer from the well, decontaminate it (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plan.

### 5.3 Indicator Parameter Method of Well Purging

1. Don personal protective clothing and equipment as specified in the site-specific health and safety plan.

2. Open the well cover and check the condition of the wellhead, including the condition of the surveyed reference mark, if any.

3. Monitor the air space at the wellhead, using a PID or equivalent, as soon as well cover is removed according to health and safety requirements.

4. Determine the depth to static water level and depth to bottom. Set up surface probe(s), (e.g., pH, conductivity) at the discharge orifice or dedicated probe port of the pump assembly or within the flow-through chamber. Allow probe(s) to equilibrate according to manufacturer's specifications. Record the equilibrated readings in the field logbook.

5. Assemble the pump and tubing, or bailer, and lower into the casing.

6. Begin pumping or bailing the well. Record indicator parameter readings for every purge volume. Maintain a record of the approximate volumes of water produced.

7. Continue pumping or bailing until indicator parameter readings remain stable within +10 percent for three consecutive recording intervals, or in accordance with site-specific plans. Purging should continue until the discharge stream is clear or turbidity becomes asymptotic-low or meets project requirements. In a low recharge aquifer, the well may pump or bail to dryness before indicator parameters stabilize. In this case, there is no need to continue purging. Record pertinent data in the field logbook.

8. Remove the pump assembly or bailer from the well, decontaminate (if required), and clean up the site. Lock the well cover before leaving. Containerize and/or dispose of development water as required by the site-specific plans.

## 6.0 Restrictions/Limitations

Where flammable, free, or emulsified product is expected, or known to exist on or in groundwater, use intrinsically safe electrical devices only and place portable power sources (e.g., generators) 15 m (50 feet) or further from the wellhead and disposal drums.

## 7.0 References

Environmental Restoration Project, *Standard Operating Procedure for Well Development*, ER-2001-0379, Rev. 2, April 27, 2001.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Quality Control Requirements For Field Methods*, DOE/HWP-69/R2, September 1996.

U.S. Department of Energy, Hazardous Waste Remedial Actions Program, *Standard Operating Procedures For Site Characterizations*, DOE/HWP-100/R2, September 1996 or current revision.

U.S. Environmental Protection Agency, *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, OSWER Directive 9355.6-14, December 1987.

# Design and Installation of Monitoring Wells in Aquifers

Prepared: Del R. Baird

Technical Review: Mark Caldwell

QA Review: James Romig

Approved: Michael C. Malley 2/24/04
Signature/Date

Issued: 2/18/04
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## 1.0 Objective

The purpose of this standard operating procedure (SOP) is to provide guidelines for the installation of groundwater monitoring wells. These guidelines will help to produce consistency of approach in the design and installation of monitoring wells. Individual installations will probably vary in some respects as they may encounter differing hydrogeologic conditions.

## 2.0 Background

### 2.1 Definitions

**Monitoring Well Installation** - The act of installing well casing, screen, filter pack, bentonite seal, grout, and other specified materials in a borehole to construct a complete monitoring well.

### 2.2 Discussion

This SOP is intended to cover the installation of monitoring wells for use in conducting a variety of environmental investigations. It is intended to be a general guideline listing the types of materials and methods to be considered when a well is installed. Materials are not specified in detail since it is likely there will be wide variability required to meet the needs of individual site conditions or specific clients. Ideally, the well should not alter the medium that is being sampled.

### 2.3 Associated Procedures

- CDM Federal SOP 3-5, Lithologic Logging
- CDM Federal SOP 4-1, Field Logbook Content and Control
- CDM Federal SOP 4-2, Photographic Documentation of Field Activities
- CDM Federal SOP 4-3, Well Development and Purging
- CDM Federal SOP 4-5, Field Equipment Decontamination at Nonradioactive Sites

## 3.0 Responsibilities

**Site Manager** - Translates client's requirements into technical direction of project. Sets technical criteria, reviews and approves technical progress, and ensures that all participating personnel have proper training. **Note**: Other titles such as project manager may be used.

**Field Team Leader (FTL)** - Supervises field operations. Assures that all necessary equipment including safety equipment is available and functioning properly before project operations begin. Assures that all necessary personnel are mobilized on time. Maintains daily log of activities each work day.

**Field Geologist** - Collects and maintains data and completes Monitoring Well Construction Forms. Coordinates and consults with site manager on decisions relative to unexpected encounters during well installation and deviation from this SOP. Directs overall activities of drill and support subcontractors.

**Drilling Subcontractor** - Provides necessary personnel, equipment, and services to meet terms of the contract.

# 4.0 Required Equipment and Materials

## 4.1 Required Equipment

- Field logbook
- Monitoring Well Construction Forms
- Measuring tape

## 4.2 Required Construction Materials

**General** - The materials that are used in the construction of a monitoring well and that come in contact with the groundwater should not measurably alter the chemical quality of a groundwater sample. The well casing and well screen should be steam cleaned (if appropriate for the selected material) prior to well installation or certified clean from the manufacturer and delivered to the site in protective wrapping. Samples of the cleaning water, drilling fluids, filter pack, annular seal, and mixed grout should be retained to be analyzed if groundwater contamination as the result of well installation is suspected. These samples will serve as quality control checks until the completion of at least one round of groundwater quality sampling and analysis.

**Water** – Water, which may be used in the well completion process, should be obtained from a source that does not contain constituents that could compromise the integrity of the well installation. A certificate of analysis should be provided with the water, or a sample of the water should be analyzed and documented as contaminant-free.

**Primary Filter Pack** - The primary filter pack (sand or gravel pack) consists of a clean, well-sorted, rounded granular material of selected grain size and gradation that is installed in the annulus between the screened interval and the borehole wall. The filter pack may be installed along the screened interval using a tremie pipe from the total depth of the well to the designated distance above the top of the screened interval. A filter pack material mostly consisting of siliceous, rather than calcareous, particles are preferred. Select the grading of the filter pack on the basis of the layer of finest material to be screened. A minimum filter pack thickness should be between 2 to 3 inches and generally never greater than 8 inches. The filter pack should extend at least 2 to 3 feet above the screened interval or more depending on the screen length to provide for filter pack settlement.

**Well Screen** - The well screen should be new and composed of materials most suited for the environment being monitored. The screened interval should be plugged at the bottom. The plug should be of the same material as the bottom section of screen and should be securely attached, making a positive seal. This assembly must have the capability to withstand well installation and development stresses without becoming dislodged or damaged. The length of the well screen slotted area should be appropriate for the interval to be monitored including some allowance for changes in elevation of the water table. Prior to installation, the casing string and associated equipment should be cleaned with steam or high-pressure water, if not certified cleaned. Well screens to be used should be composed of stainless steel or polyvinyl chloride (PVC), as appropriate. Fluoropolymer materials may be substituted if necessary due to the potential for incompatible chemical reactions between contaminants and the stainless steel screen, or if stainless steel constituents are possible site contaminants. The minimum internal diameter of the well screen should be chosen based on the particular application. Well screens should be flush threaded per American Society for Testing and Materials (ASTM) standards. Glued or solvent-welded joints may not be used since glues and solvents may alter the chemistry of the water samples.

**Slot Size** - The slot size of the well screen should be determined relative to the grain-size analysis of the stratum to be monitored and the gradation of the filter pack material. In granular non-cohesive strata that falls in easily around the screen, filter packs may not be necessary. In these cases of natural development, the slot size of the well screen is to be determined using the grain size of the materials in the surrounding strata. The slot size and arrangement should retain at least 90 percent of the filter pack.

**Casing** - The well casing will be composed of PVC, stainless steel, or some other appropriate material and will extend from the screen to the surface. The type of casing and wall thickness should be adequate to withstand the forces of installation. Several different casing sizes may be required depending on the subsurface geologic conditions. The diameter of the casing for filter packed wells should be selected so that a minimum annular space of 2 inches is maintained between the casing and the borehole wall. The diameter of the casings in multi-cased wells should be selected so that a minimum annular space of 2 inches is maintained between casing strings and between the outer casing and the borehole (e.g., a 2-inch-diameter well screen will require first setting a 6-inch-diameter casing in a 10-inch-diameter boring). Under difficult drilling conditions (collapsing soils, rock, or cobbles), it may be necessary to advance temporary casing. Under these conditions, a smaller space may be maintained. The ends of each casing section should be flush-threaded.

**Protective Casing** - Protective casings may be made of galvanized steel (or rarely stainless steel). The protective casing should have a lid capable of being secured by a locking device. The inside dimensions of the protective casing should be at a minimum 4 inches larger than the diameter of the casing to facilitate the installation and operation of sampling equipment. Protective casing should extend approximately 2 to 3 feet into the ground to anchor it securely.

**Annular Sealants** - The materials used to seal the annulus may be prepared as a slurry or used un-mixed in a dry pellet form. Sealants should be selected for compatibility with local geologic, hydrogeologic, climatic, and human-induced conditions anticipated to occur during the life of the well.

**Bentonite** - Bentonite should be powdered or pelletized sodium montmorillonite furnished in sacks or buckets from a commercial source and free of impurities that adversely impact water quality in the well. The diameter of pellets selected for monitoring well construction should be less than one-fifth the width of the annular space into which they are placed to reduce the potential for bridging. Pellets are typically used for placing annular seals, and powdered bentonite is used for mixing in grout slurry.

**Cement** - Each type of cement has slightly different characteristics that may be appropriate under various physical and chemical conditions. Cement should generally be Portland Type I, Type II, or Type I/II as specified in ASTM C 150. Quick-setting cements containing additives are not allowable for use in monitoring well installation. Additives may leach from the cement and influence the chemistry of the groundwater.

**Grout** - The grout backfill that is placed above the bentonite annular seal should be a liquid slurry consisting of water, bentonite grout of Volclay or equivalent quality, and Portland cement. Bentonite-based grouts are typically used when a more flexible grout is desired (i.e., freeze-thaw). Cement-based grout provides a more rigid installation. A typical bentonite grout mixture is 1 to 1.25 pounds bentonite to 2 pounds of Type I Portland Cement per gallon of water. Cement-based grout is typically 6 to 7 gallons of water per 94 pound bag of Type I Portland Cement and 2.7 percent bentonite powder.

**Transition Sand** - A layer of fine to very fine sand may be placed on top of the primary filter pack before emplacement of the bentonite seal. It should be of sufficient thickness to prevent bentonite from penetrating to the vicinity of the well screen during placement of the bentonite seal.

**Annular Seal Equipment (Tremie Pipe)** - A tremie pipe is used to inject the annular seals and filter pack. Tremie pipes are typically constructed of PVC or galvanized steel. Associated equipment may include a trough or mixing box and "mud pump" to place the material.

**Primary Filter Pack** - Screened and washed sand that is placed between the well screen and the borehole wall the full length of the screen.

# 5.0 Procedures

## 5.1 Drilling Methods

The actual methods of drilling at a site will vary depending on site conditions. The method to be used at a site shall be stated in the site-specific plans. Deviations from the methods prescribed in these plans shall be approved by the FTL. Typical drilling methods include air rotary, mud/fluid rotary, and hollow-stem auger. Drilling with mud, foam, or water is not desirable, but the driller shall have the capability to use this method if hole conditions warrant it. Installation of wells drilled by mud, foam, water, or air rotary shall be reamed to the appropriate borehole diameter. Installation of wells with protective casing shall be done by either penetrating the outer casing into the ground by hammer blows or by drilling a borehole. The outer casing should be set and secured by grouting or other means specified in the site-specific plans. The inner well borehole can then be drilled through the center of the outside casing. The monitoring wells shall be drilled vertical or at an angle if specified in the site-specific plans. The wells shall be drilled to a depth specified in the site-specific plans and may vary based on actual lithologic conditions. The depth to completion should be approved by the FTL prior to monitoring well construction. Drillers must prevent grease, oil, and other fluids from the drill rig from coming in contact with the ground around the area of well installation.

## 5.2 Monitoring Well Installation

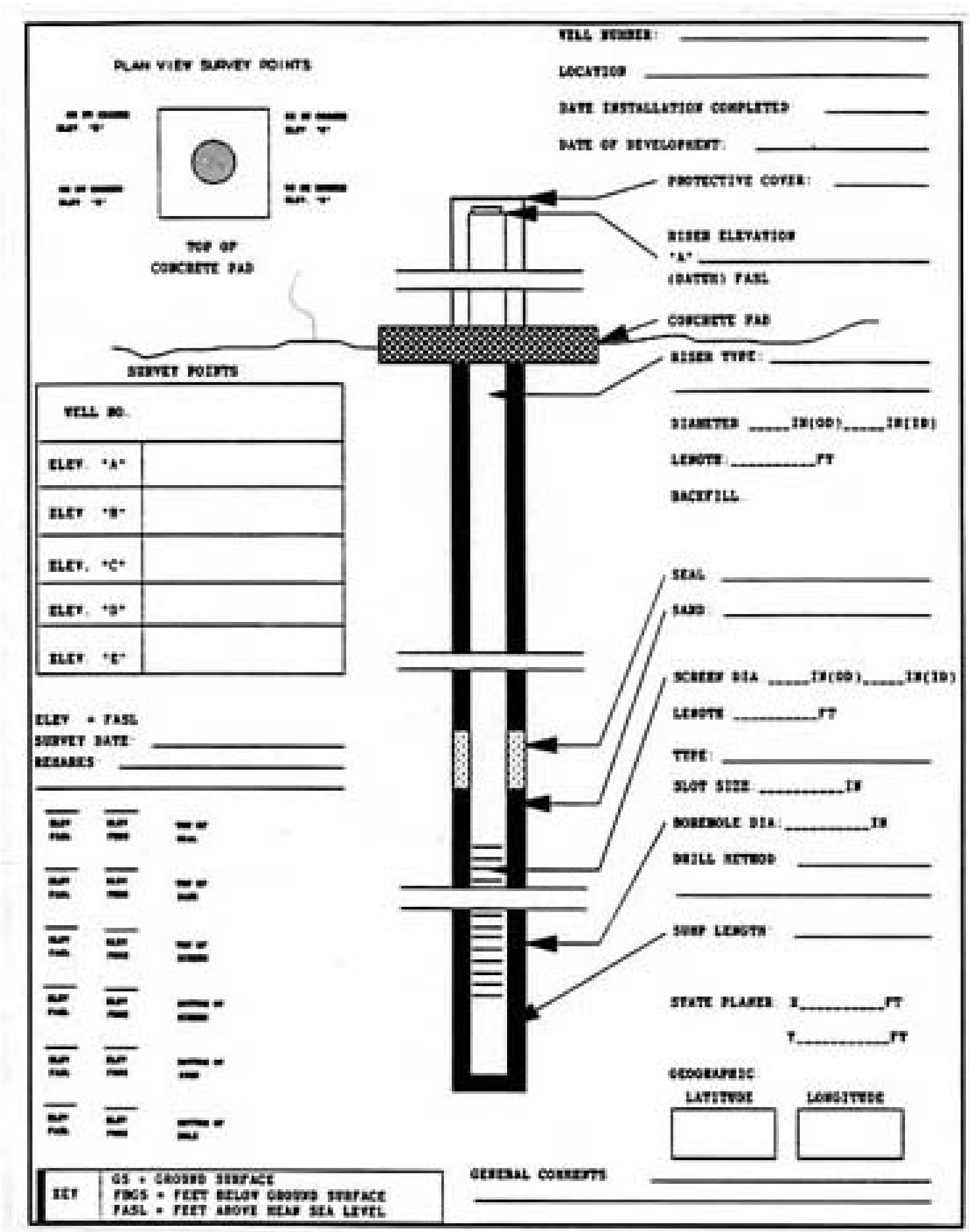
### 5.2.1 Stable Borehole

A stable borehole must be constructed prior to attempting to install the monitoring well casing and assembly. Steps must be taken to stabilize the borehole before attempting installation if the borehole tends to cave or blow-in, or both. Boreholes that are not straight or are partially obstructed should be corrected prior to attempting the installations described herein.

Although all monitoring wells will not be completed exactly alike, there are common elements among them. The Monitoring Well Construction Form (Figure 1 or equivalent) must be completed by the end of the activity with data obtained through the installation process. The well construction field form should be reviewed prior to initiation of drilling activities to assure that the required data are collected at appropriate times during drilling and installation.

Some monitoring wells may require collection of continuous core, which will be maintained from surface to total depth. Samples may be collected by the wire line coring method (or split-spoon sampler). A description of soil/lithologic materials and drilling observations needs to be recorded in a boring logbook (CDM Federal SOP 3-5).

### Figure 1 - Monitoring Well Construction Form



The retrieved samples will be visually screened for indications of water saturation to identify any perched zone and associated impervious layer. If there is sufficient groundwater in a perched zone, a monitoring well may be completed in that zone. Operations will resume if the suspected saturated interval is determined not to be perched water or to be of insufficient thickness to warrant well construction.

For wells not completed in perched zones, the drilling method should ensure isolation of the perched water from the advancing hole, which can be accomplished by an outer protective casing. This method, however, may require short core sections to maintain a close interval between the drive casing and the core depth (that is, until the perched water zone has been completely penetrated). During completion of the well through the perched water zones, the cement grout should stay well above the retracting drive casing shoe.

**5.2.2 Well Casing Assembly**
The well screen, casing, and bottom plug should be either certified clean from the manufacturer or decontaminated according to CDM Federal SOP 4-5.

Personnel should take precautions to assure that grease, oil, or other contaminants that may alter water samples do not contact any portion of the well casing assembly. As a precaution, personnel should wear a pair of clean gloves while handling the assembly.

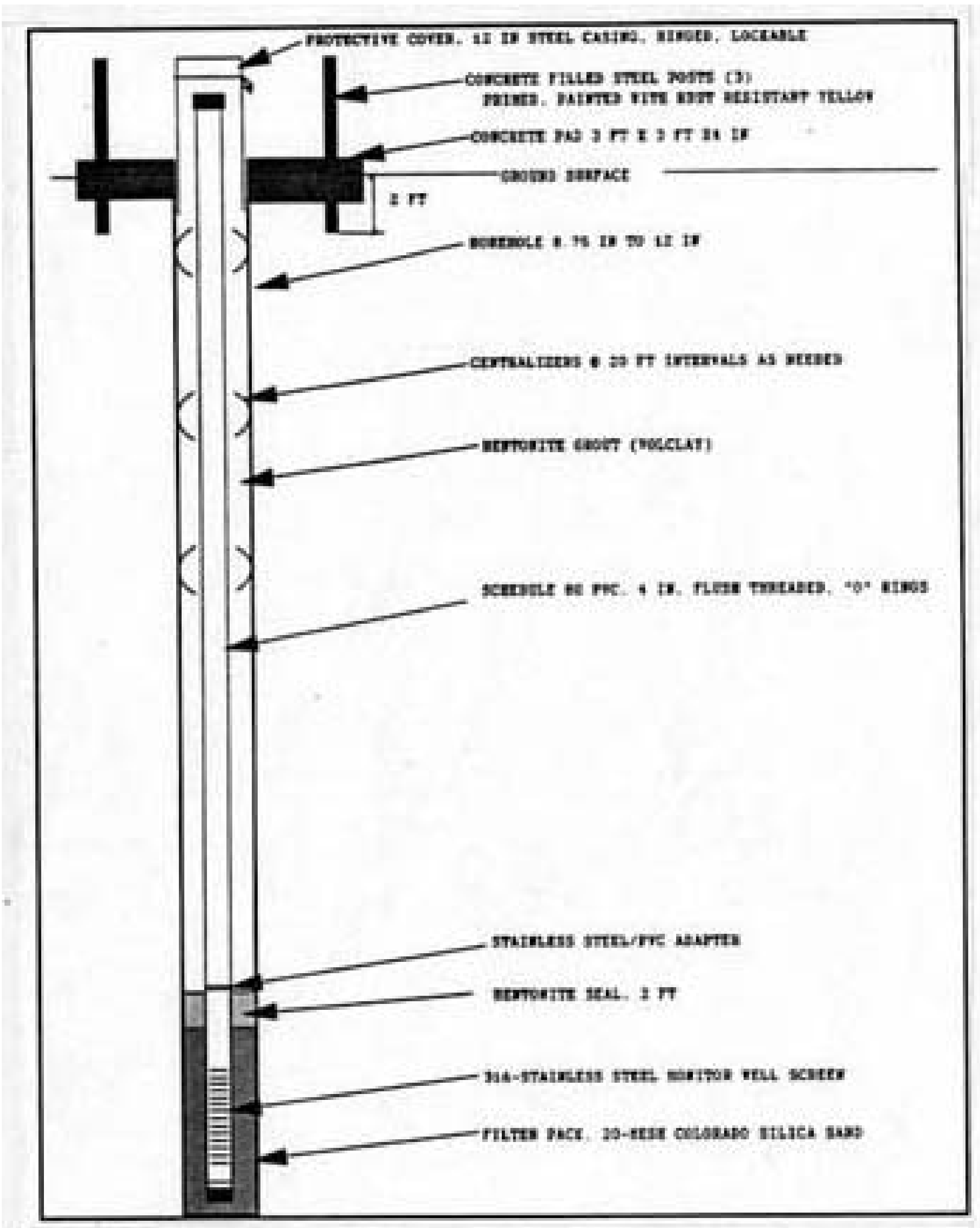
Normally, couplings are tightened by hand; however, steam- or high-pressure-cleaned strap wrenches may also be used. Use pipe wrenches with care as they may scar and weaken the pipe. Precautions should be taken to prevent damage to the threaded joints during installation.

**5.2.3 Setting the Well Screen and Casing Assembly in Fluid Filled Holes**
When the well screen and casing assembly is lowered to the predetermined level and held in position, the assembly may require a ballast to counteract the tendency to float in the borehole. Ballasting may be accomplished by continuously filling the casing assembly with contaminant-free water. If fluid ballasts are used, the quantity introduced must be recorded in the field logbook. Alternatively, the casing assembly may be slowly pushed into the fluid in the borehole with the aid of hydraulic rams on the drill rig and held in place as additional sections of casing are added to the column. Care must be taken to secure the casing assembly so that personnel safety is assured during the installation. For wells greater than 100 feet, the assembly should be installed straight using centralizers at selected intervals.

Difficulty in maintaining a straight installation may be encountered when the weight of the well screen and casing assembly is significantly less than the buoyant force of the fluid in the borehole. The casing should extend to grade or approximately 2 feet above grade, depending on the intended surface completion, and be capped or covered temporarily to deter entrance of foreign materials during completion operations.

A typical monitoring well is illustrated in Figure 2 - Typical Construction Detail of Monitor Well. Modification of the construction and dimensions on this diagram may be needed depending on site-specific conditions. The monitoring wells will be completed with material as approved by the FTL. The casing should be flush-threaded, using Schedule 40 PVC or other suitable monitoring well casing. No adhesives, cements, or lubricants shall be used during casing make-up or during other drilling and well completion operations.

**Figure 2 - Typical Construction Detail of Monitor Well**
**(Not to Scale - Shown as an Example Only)**



**5.2.4 Installation of the Primary Filter Pack**

Placement of the casing assembly is followed by placing the primary filter pack sand/filter pack (consisting of silica sand sized according to the average grain size of the screened formation) into the bottom of the borehole by using a tremie pipe. The remaining primary filter pack is then placed in increments as the tremie is gradually raised. The sand pack will be emplaced by the "washdown" gravity method and the depth to the top of the sand pack shall be determined and recorded frequently during the operation to ensure proper placement. The tremie pipe or a weighted line inserted through the tremie pipe can be used to measure the top of the primary filter pack as work progresses. As primary filter pack material is poured into the tremie pipe, water from a source of known chemistry may be added to help move the filter pack. The quantity of water introduced must be recorded. If bridging of the primary filter pack occurs, the bridged material should be broken mechanically prior to proceeding with the addition of more filter pack material. The depth, volume, and gradation of the primary filter pack will be recorded on the well construction diagram.

If used, temporary casing or auger sections will be withdrawn in increments. Care should be taken to minimize lifting the casing with the withdrawal of the temporary casing/augers. To limit borehole collapse, the temporary casing or hollow-stem auger is usually withdrawn until the lowermost point on the temporary casing or hollow-stem auger is at least 2 feet, but no more than 5 feet, above the filter pack for unconsolidated materials; or at least 5 feet, but no more than 10 feet, for consolidated materials. Ascertain the depth of the sand with an acceptable measuring device or with tremie pipe and verify the thickness of the sand pack. The primary filter pack is typically placed a minimum of 2 feet above the top of the well screen to account for settlement of the filter pack.

**5.2.5 Installation of the Bentonite Seal**

A minimum 2-foot-thick bentonite seal should be emplaced on top of the filter pack or transition sand (if used) by using a tremie pipe, if required. If the tremie pipe becomes plugged, requiring an increase in pressure to clear it, not less than 20 feet of tremie pipe shall be pulled up to avoid jetting into the sand pack. If the seal is installed above the water level, water shall be added to allow proper hydration of the annular seal (approximately 1 gallon for each linear foot of annular seal). The volume and depth of the bentonite seal material should be measured and recorded on the well construction diagram.

**5.2.6 Grouting the Annular Space**

The following procedures apply to both single- and multi-cased monitoring wells. However, it should be noted that grouting procedures will vary with the type of well design.

A sufficient volume of grout should be premixed onsite, according to procedure stipulated by the manufacturer, to compensate for unexpected losses and checked against the known volume of annular space to ensure that bridging does not occur during emplacement. The use of alternate grout materials, including grout containing Portland cement, may be necessary to control zones of high grout loss. The mixing (and placing) of grout should be performed with recorded weights and volumes of materials, according to procedures stipulated by the manufacturer. Lumpy grout should not be used in an effort to prevent bridging within the tremie and the well; however, lost circulation materials may be added to the grout if excessive grout loss occurs. Bentonite-based grout of Volclay or equivalent type should be mixed to the manufacturer's specifications then pumped into place using minimum pump pressure. All additives to grouts should be evaluated for their effects on subsequent water samples.

Depending upon the well design, grouting may be accomplished using a pressure grouting technique or by gravity feed through a tremie pipe. With either method, grout is introduced in one continuous operation until grout flows out at the ground surface without evidence of drill cuttings or fluid. The grout backfill should be injected under pressure using a tremie pipe to reduce the possibility of leaving voids in the annular seal and to displace any liquids and drill cuttings that may remain in the annulus.

Grouting should begin directly above the bentonite seal, after the bentonite has been adequately hydrated. Grout should be injected using a tremie pipe. The tremie pipe should be kept full of grout from start to finish with the discharge end of the pipe completely submerged as it is slowly and continuously lifted. Pump pressure shall be kept to a minimum. Approximately 5 to 10 feet of tremie pipe should remain submerged during group emplacement. If possible, steel tape soundings should be made to ensure the level of the tremie material is in agreement with the calculated volume and that the desired placement of annular materials is achieved. A staged grouting procedure may be considered if the couplings of the selected casing cannot withstand the shear or if there is collapse stress exerted by the full column of grout as it sets. If used, the temporary casing or hollow-stem auger should be removed in increments (immediately following each lift of grout installation) well in advance of the time when the grout begins to set. The initial grout mixture must be allowed to cure for approximately 12 hours, then refilled to the surface.

The well casing should not be developed until the grout sets and cures for the amount of time necessary to prevent a break in the seal between the grout and casing. The amount of time required (generally 24 to 48 hours) will vary with grout content and climate conditions and should be documented on the well completion diagram along with the volume and depth of grout used to backfill the annular space.

### 5.3 Well Protection

Well protection refers specifically to installations made at or above the ground surface to deter unauthorized entry to the monitoring well and to prevent surface water from entering the annulus.

The protective casing should extend from below the frost line (at least 2 feet below grade) to slightly above the well casing top. The protective casing should be sealed and immobilized in concrete that has been placed around the outside of the protective casing above the set grout backfill. The casing should be positioned and stabilized in a position concentric with the casing. Clearance (usually 6 inches) should be maintained between the lid of the protective casing and the top of the casing to accommodate sampling equipment. A ¼-inch-diameter weep hole should be drilled in the protective casing at the ground surface to permit water to drain out of the annular space. This hole will also prevent water freezing between the well protector and the well casing.

All materials used should be documented on the well construction diagram. The monitoring well identification number should be clearly visible on the inside and outside of the lid of the protective casing and the outside of the protective casing.

A 3-feet x 3-feet x 6-inch-thick concrete pad, sloped to provide water drainage away from the well, may be placed around the installation. Pad size may vary according to site conditions or client specifications. Three 2½-inch-diameter concrete-filled steel posts set at least 24 inches below the surface in concrete should be equally spaced around the well to protect against damage by vehicular traffic for aboveground well completions. The protective casing and steel posts may be primed and painted with rust-resistant yellow paint.

A flush-mounted, traffic-rated casing or vault is typically used for the surface completion of monitoring wells installed in high-use paved areas. The well box cover should be finished slightly above pavement surface to prevent water entry. A layer of sand or gravel material should be placed under the casing/vault to allow infiltrating surface water to drain out.

### 5.4 Post Operation

#### 5.4.1 Field

At the conclusion of the monitoring well installation activities, all equipment must be decontaminated (according to CDM Federal SOP 4-5) prior to moving the equipment to a different work location. All water used in the decontamination of drilling equipment will be contained in an appropriate container, if required in the site-specific plans.

#### 5.4.2 Documentation

The Groundwater Monitoring Well Construction Form (Figure 1 or equivalent) should be completed by the CDM FTL or designee at the conclusion of the field activity.

Copies of all field notes, the daily logs, and any completed Groundwater Monitoring Well Construction Forms shall be given to the site manager. These records shall be maintained in the project and document control files. At a minimum, all materials used for construction should be documented by entering identifying numbers (lot numbers, manufacturer's identification, etc.) in the field logbook. Samples of well materials (including grout, sand, etc.) may be archived if specified in the project plans.

## 6.0 Restrictions and Limitations

None.

## 7.0 References

American Society for Testing and Materials, Designation: D 5092-90*, Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers*, ASTM Committee D-18-.21.05. October 1990.

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# Field Equipment Decontamination at Nonradioactive Sites

SOP 4-5
Revision: 6
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**Issued:** 12/28/04
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## 1.0 Objective

The objective of this standard operating procedure (SOP) is to describe the general procedures required for decontamination of field equipment at nonradioactive sites. This SOP serves as a guide and is applicable at most sites; however, it should be noted that site-specific conditions (i.e., type of contamination, type of media sampled) and the governing agency (i.e., EPA, DOE, USACE) may require modifications to the decontamination procedures provided in this SOP.

## 2.0 Background

### 2.1 Definitions

**Acid Rinse** - A solution of 10 percent nitric or hydrochloric acid made from reagent grade acid and analyte-free water.

**Analyte-Free Water** - Tap water that has been treated so that the water contains no detectable heavy metals or other inorganic compounds. Analyte-free water should be stored only in clean glass, stainless steel, or plastic containers that can be closed when not in use.

**Clean** - Free of visible contamination and when decontamination has been completed in accordance with this SOP.

**Cross Contamination** - The transfer of contaminants through equipment or personnel from the contamination source to less contaminated or noncontaminated samples or areas.

**Decontamination** - The process of rinsing or otherwise cleaning the surfaces of equipment to rid them of contaminants and to minimize the potential for cross contamination of samples or exposure of personnel.

**Organic-Free/Analyte-Free Water** - Tap water that has been treated so that the water meets the analyte-free water criteria and contains no detectable organic compounds. Organic-free/analyte-free water should be stored only in clean glass, Teflon™, or stainless steel containers that can be closed when not in use.

**Potable Water** - Tap water may be obtained from any municipal system. Chemical analysis of the water source may be required before it is used.

**Soap** - Low-sudsing, nonphosphate detergent such as Liquinox™.

**Solvent Rinse** - Pesticide grade, or better, isopropanol, acetone, or methanol.

### 2.2 Discussion

Decontamination of field equipment is necessary to ensure acceptable quality of samples by preventing cross contamination. Further, decontamination reduces health hazards and prevents the spread of contaminants offsite.

## 3.0 Responsibilities

**Field Team Leader** - The field team leader (FTL) ensures that field personnel are trained in the performance of this procedure and that decontamination is conducted in accordance with this procedure. The FTL may also be required to collect and document rinsate samples to provide quantitative verification that these procedures have been correctly implemented.

## 4.0 Required Equipment

- Stiff-bristle scrub brushes
- Plastic buckets and troughs
- Soap
- Nalgene or Teflon sprayers or wash bottles or 2- to 5-gallon, manual-pump sprayer (pump sprayer material must be compatible with the solution used)
- Plastic sheeting
- Disposable wipes, rags, or paper towels
- Potable water*
- Analyte-free water
- Organic-free/analyte-free water
- Gloves, safety glasses, and other protective clothing as specified in the site-specific health and safety plan
- High-pressure pump with soap dispenser or steam-spray unit (for large equipment only)
- Appropriate decontamination solutions pesticide grade or better and traceable to a source (e.g., 10 percent and/or 1 percent nitric acid [$HNO_3$], acetone, methanol, isopropanol, hexane)
- Tools for equipment assembly and disassembly (as required)
- 55-gallon drums or tanks (as required)
- Pallets for drums or tanks holding decontamination water (as required)

* Potable water may be required to be tested for contaminants before use. Check field plan for requirements.

## 5.0 Procedures

All reusable equipment (nondedicated) used to collect, handle, or measure samples will be decontaminated before coming into contact with any sample. Decontamination of equipment will occur either at a central decontamination station or at portable decontamination stations set up at the sampling location, drill site, or monitoring well location. The centrally located decontamination station will include an appropriately sized bermed and lined area on which equipment decontamination will occur and shall be equipped with a collection system and storage vessels. In certain circumstances, berming is not required when small quantities of water are being generated and for some short duration field activities (i.e., pre-remedial sampling). Equipment should be transported to the decontamination station in a manner to prevent cross contamination of equipment and/or area. Precautions taken may include enclosing augers in plastic wrap while being transported on a flatbed truck.

The decontamination area will be constructed so that contaminated water is either collected directly into appropriate containers (5-gallon buckets or steel wash tubs) or within the berms of the decontamination area that then drains into a collection system. Water from the collection system will be transferred into 55-gallon drums or portable tanks for storage. Typically, decontamination water will be staged until sampling results or waste characterization results are obtained and evaluated and the proper disposition of the waste is determined. The exact procedure for decontamination waste disposal should be discussed in the field plan. Also, solvent and acid rinse fluids may need to be segregated from other investigation-derived wastes.

All items that will come into contact with potentially contaminated media will be decontaminated before use and between sampling and/or drilling locations. If decontaminated items are not immediately used, they will be covered either with clean plastic or aluminum foil depending on the size of the item. All decontamination procedures for the equipment being used are as follows:

**General Guidelines**

- Potable, analyte-free, and organic-free/analyte-free water should be free of all contaminants of concern. Following the field plan, analytical data from the water source may be required.

- Sampling equipment that has come into contact with oil and grease will be cleaned with methanol or other approved alternative to remove the oily material. This may be followed by a hexane rinse and then another methanol rinse. Regulatory or client requirements regarding solvent use will be stated in the field plan.

- All solvents and acids will be pesticide grade or better and traceable to a source. The corresponding lot numbers will be recorded in the appropriate logbook. Solvents and acids are potentially hazardous materials and must be handled, stored, and transported accordingly. Solvents should never be used in a closed building. See the site-specific health and safety plan and/or the chemical's Material Safety Data Sheet (MSDS) for specific information regarding the safe use of the chemical.

- Decontaminated equipment will be allowed to air dry before being used.

- Documentation for all cleaning will be recorded in the appropriate logbook.

- Gloves, boots, safety glasses, and any other personnel protective clothing and equipment will be used as specified in the site-specific health and safety plan.

## 5.1 Heavy Equipment Decontamination

Heavy equipment includes drilling rigs and backhoes. Follow these steps when decontaminating this equipment:

- Establish a bermed decontamination area that is large enough to fully contain the equipment to be cleaned. If available, an existing wash pad or appropriate paved and bermed area may be used; otherwise, use one or more layers of heavy plastic sheeting to cover the ground surface and berms. All decontamination pads should be upwind of the area under investigation.

- With the rig in place, spray areas (rear of rig or backhoe) exposed to contaminated soils using a hot water high-pressure sprayer. Be sure to spray down all surfaces, including the undercarriage.

- Use brushes, soap, and potable water to remove dirt whenever necessary.

- Remove equipment from the decontamination pad and allow it to air dry before returning it to the work site.

- Record the equipment type, date, time, and method of decontamination in the appropriate logbook.

- After decontamination activities are completed, collect all contaminated wastewater, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal as detailed in the field plan. Liquids and solids must be drummed separately.

## 5.2 Downhole Equipment Decontamination

Downhole equipment includes hollow-stem augers, drill pipes, rods, stems, etc. Follow these steps when decontaminating this equipment:

- Set up a centralized decontamination area, if possible. This area should be set up to collect contaminated rinse waters and to minimize the spread of airborne spray.

- Set up a "clean" area upwind of the decontamination area to receive cleaned equipment for air-drying. At a minimum, clean plastic sheeting must be used to cover the ground, tables, or other surfaces on which decontaminated equipment is to be placed. All decontamination pads should be upwind of any areas under investigation.

- Place the object to be cleaned on aluminum foil or plastic-covered wooden sawhorses or other supports. The objects to be cleaned should be at least 2 feet above the ground to avoid splashback when decontaminating.

- Using soap and potable water in the hot water high-pressure sprayer (or steam unit), spray the contaminated equipment. Aim downward to avoid spraying outside the decontamination area. Be sure to spray inside corners and gaps especially well. Use a brush, if necessary, to dislodge dirt.

- If using soapy water, rinse the equipment using clean, potable water. If using hot water, the rinse step is not necessary if the hot water does not contain a detergent. If the hot water contains a detergent, this final clean water rinse is required.

- Using a suitable sprayer, rinse the equipment thoroughly with analyte-free water.

- Remove the equipment from the decontamination area and place in a clean area upwind to air dry.

- Record equipment type, date, time, and method of decontamination in the appropriate logbook.

- After decontamination activities are completed, collect all contaminated wastewaters, plastic sheeting, and disposable gloves, boots, and clothing in separate containers or receptacles. All receptacles containing contaminated items must be properly labeled for disposal. Liquids and solids must be drummed separately.

### 5.3 Sampling Equipment Decontamination

Sampling equipment is defined as equipment that comes into direct contact with the sample media. Such equipment includes split spoon samplers, well casing and screens, and spatulas or bowls used to homogenize samples. Follow these steps when decontaminating this equipment:

- Set up a decontamination line on plastic sheeting. The decontamination line should progress from "dirty" to "clean." A clean area shall be established upwind of the decontamination wash/rinse activities to dry the equipment. At a minimum, clean plastic sheeting must be used to cover the ground, table, or other surfaces that the decontaminated equipment is placed for drying.

- Disassemble any items that may trap contaminants internally. Do not reassemble the items until decontamination and air drying are complete.

- Wash the items with potable water and soap using a stiff brush as necessary to remove particulate matter and surface films. The items may be steam cleaned using soap and hot water as an alternative to brushing. Note that polyvinyl chloride or plastic items should not be steam cleaned. Items that have come into contact with concentrated and/or oily contaminants may need to be rinsed with a solvent such as hexane and allowed to air dry prior to this washing step.

- Thoroughly rinse the items with potable water.

- If sampling for metals, thoroughly rinse the items with an acid solution (e.g., 10 percent nitric acid) followed by a rinse using analyte-free water. If sampling for organic compounds, thoroughly rinse the items with solvent (e.g., isopropanol) followed by a rinse using analyte-free water. The specific chemicals used for the acid rinse and solvent rinse phases should be specified in the work plan. The acid rinsate and solvent rinsate must each be containerized separately. Acids and solvents are potentially hazardous materials and care must be exercised when using these chemicals to prevent adverse health affects (e.g., skin burns, irritation to the eyes and respiratory system, etc.). Appropriate personal protective equipment must be worn when using these chemicals. These chemicals (including spent rinsate) must be managed and stored appropriately. Special measures such as proper labels, paperwork, notification, etc. may be required when transporting or shipping these chemicals.

- Rinse the items thoroughly using organic-free/analyte-free water.

- Allow the items to air dry completely.

- After drying, reassemble the parts as necessary and wrap the items in clean plastic wrap or in aluminum foil.
- Record equipment type, date, time, and method of decontamination in the appropriate logbook.
- After decontamination activities are completed, collect all contaminated waters, used solvents and acids, plastic sheeting, and disposable personal protective equipment. Place the contaminated items in properly labeled drums for disposal. Liquids and solids must be drummed separately. Refer to site-specific plans for labeling and waste management requirements.

## 5.4 Pump Decontamination

Follow the manufacturer's recommendation for specified pump decontamination procedures. At a minimum, follow these steps when decontaminating pumps:

- Set up the decontamination area and separate “clean” storage area using plastic sheeting to cover the ground, tables, and other surfaces. Set up four containers: the first container shall contain dilute (nonfoaming) soapy water, the second container shall contain potable water, the third container shall be empty to receive wastewater, and the fourth container shall contain analyte-free water.
- The pump should be set up in the same configuration as for sampling. Submerge the pump intake (or the pump, if submersible) and all downhole-wetted parts (tubing, piping, foot valve) in the soapy water of the first container. Place the discharge outlet in the wastewater container above the level of the wastewater. Pump soapy water through the pump assembly until it discharges to the waste container. Scrub the outside of the pump and other wetted parts with a metal brush.
- Move the pump assembly to the potable water container while leaving discharge outlet in the waste container. All downhole-wetted parts must be immersed in the potable water rinse. Pump potable water through the pump assembly until it runs clear.
- Move the pump intake to the analyte-free water container. Pump the water through the pump assembly. Pump the volume of water through the pump specified in the field plan. Usually, three pump-and-line-assembly volumes will be required.
- Decontaminate the discharge outlet by hand, following the steps outlined in Section 5.3.
- Remove the decontaminated pump assembly to the clean area and allow it to air dry upwind of the decontamination area. Intake and outlet orifices should be covered with aluminum foil to prevent the entry of airborne contaminants and particles.
- Record the equipment type, serial number, date, time, and method of decontamination in the appropriate logbook.

## 5.5 Instrument Probe Decontamination

Instrument probes used for field measurements such as pH meters, conductivity meters, etc. will be decontaminated between samples and after use with analyte-free, or better, water.

## 5.6 Waste Disposal

Refer to site-specific plans for waste disposal requirements. The following are guidelines for disposing of wastes:

- All wash water, rinse water, and decontamination solutions that have come in contact with contaminated equipment are to be handled, packaged, labeled, marked, stored, and disposed of as investigation-derived waste.
- Small quantities of decontamination solutions may be allowed to evaporate to dryness.

- If large quantities of used decontamination solutions will be generated, each type of waste should be contained in separate containers.
- Unless otherwise required, plastic sheeting and disposable protective clothing may be treated as solid, nonhazardous waste.
- Waste liquids should be sampled, analyzed for contaminants of concern in accordance with disposal regulations, and disposed of accordingly.

## 6.0 Restrictions/Limitations

Nitric acid and polar solvent rinses are necessary only when sampling for metals or organics respectively. These steps should not be used, unless required, because of the potential for acid burns and ignitability hazards.

If the field equipment is not thoroughly rinsed and allowed to completely air dry before use, volatile organic residue, which interferes with the analysis, may be detected in the samples. The occurrence of residual organic solvents is often dependent on the time of year sampling is conducted. In the summer, volatilization is rapid, and in the winter, volatilization is slow. Check with your EPA region, state, and client for approved decontamination solvents.

## 7.0 References

American Society for Testing and Materials. 2002. *Standard Practice for Decontamination of Field Equipment at Nonradioactive Waste Sites*, ASTM D5088-02. January 10.

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| **QA Review:** | Doug Updike | **Approved:** | Michael C. Malloy 12/21/04 Signature/Date |
| **Issued:** | 12/28/04 Signature/Date | | |

## 1.0 Objective

The objective of this standard operating procedure (SOP) is to define requirements for conducting and analyzing in situ hydraulic conductivity (slug) tests in small, developed wells.

## 2.0 Background

Selected monitoring wells are used to approximate local hydraulic conductivity using either rising-head or falling-head slug test methods.

Slug testing is a rapid and easy means of estimating the hydraulic conductivity of an aquifer. If the thickness of the aquifer is known, then the transmissivity can also be determined. Advantages of slug testing over pump testing include the fact that little or no contaminated water is produced requiring containment and disposal as well as that several areas can be tested in a relatively short period of time. A disadvantage is that the resulting estimate of hydraulic conductivity is limited to a small volume of the aquifer around the tested well and care must be taken in extrapolating the results from one well to other areas or intervals of the aquifer.

Slug testing is accomplished by adding (or removing/displacing) a known volume to (or from) the monitoring well to create a rapid rise (or fall) in water level. Water levels are then measured as the water level in the well returns to static (pre-test) conditions. The most common practice for displacing water in the well is to use a weighted cylinder (also known as a slug bar) of known volume. A bailer may be used in place of a slug bar under low-recharge aquifer conditions.

In addition, a pneumatic system can also be used to lower the water level. This system uses an air pump, compressor or compressed air cylinder to increase the air pressure in the well, which is sealed with an air-tight cap that has ports through which the compressed air is introduced and a water level indicator or pressure transducer can be inserted. This displacement method is commonly employed in high transmissivity aquifers, where sufficient displacement is difficult to achieve using a slug bar or bailer.

In all cases, the rate of water level recovery is then measured using a pressure transducer and data recorder or a water level meter and stopwatch (the former method is preferable in most environments). Data, as displacement-time pairs, are then graphed and used in equations to determine hydraulic conductivity.

If possible, when designing the field program or considering in which interval to place a well screen, try to screen only one formation type. If a well is screened across more than one formation (such as fine sand and coarse sand or overburden and bedrock), it will not be possible to attribute the slug test response to either formation with any accuracy.

### 2.1 Associated SOPs

- CDM Federal (CDM) SOP 1-5, *Groundwater Sampling with Bailers*
- CDM SOP 1-6, *Water Level Measurement*
- CDM SOP 2-6, *Handling Investigative-Derived Waste*
- CDM SOP 4-1, *Field Logbook Content and Control*
- CDM SOP 4-3, *Well Development and Purging*
- CDM SOP 4-4, *Design and Installation of Monitoring Wells in Aquifers*
- CDM SOP 4-5, *Field Equipment Decontamination at Nonradioactive Sites*

## 3.0 Responsibilities

**Site Manager** - The site manager is responsible for ensuring that field personnel have been trained in conducting slug tests and for ensuring that slug tests are conducted in accordance with this procedure.

**Field Team Leader** - The field team leader is responsible for performing slug tests in accordance with this procedure and for verifying that the data collected are adequate and of high quality. The project field geologist should perform a field calculation to check data quality.

## 4.0 Required Equipment

The following equipment should be used when performing a rising or falling-head slug test in a monitoring well. Site-specific conditions may warrant the use of additional equipment.

- Pressure transducer and data recorder, if data are to be automatically recorded (recommended), and manufacturers' instructions
- Laptop or hand-held computer for downloading and viewing data (field printer optional)
- Water level measuring device
- Stopwatch, if measurements collected manually (not recommended)
- Slug device of known volume
- Rope or wire
- Duct tape
- Field logbook
- Decontamination equipment and supplies
- Data on the construction of the well: depth to screen, screen length, well drilled diameter, riser diameter, height of sandpack above screen and length of riser above ground surface

Note that the well construction data shall be used so that the slug test data being collected are appropriate and of acceptable quality. Additional information (e.g., distance from screen to confining layer) may be necessary to analyze the data and determine the hydraulic conductivity. Data analysis is not covered under this procedure.

The slug bar shall be constructed of plastic, such as polyvinyl chloride (PVC), or metal such as aluminum or steel (depending upon the chemical environment in the well) and have no buoyancy. For example, a standard slug is constructed with a PVC pipe filled with sand and capped at both ends. The slug bar should be of sufficient size to cause a recommended minimum of 2 feet of displacement in a well. A slightly lesser or greater head change is acceptable so long as a sufficient response curve is recorded that can be applied in a subsequent analysis. For a 2-inch diameter monitoring well, the slug bar should be no more than 1.5 inches in diameter and a minimum of 5 feet long. For a 4-inch diameter well, the slug bar should be no more than 3 inches in diameter and a minimum of 5 feet long. The slug bar should be securely fastened to a nylon rope or braided metal wire.

A standard sampling or well development bailer may be used in place of the slug bar, as long as the volume of water displaced by the bailer is sufficient to change the water level in the well a minimum of 2 feet. If the bailer is to be used for a falling-head test, it should be filled with analyte-free water so that the bailer will not have any buoyancy.

## 5.0 Procedures

### 5.1 Preparation

The following steps must be followed when preparing for slug testing:

- Lay plastic sheeting around the wellhead. Arrange needed equipment and decontamination materials on the sheet.

- Put on personnel protective clothing, as specified in the site-specific health and safety plan.

- Open the protective casing locking lid and vented riser caps following the procedures outlined in SOP 1-6. Note the physical condition of the well, including damage, deterioration and signs of tampering. Note any unusual odors, sounds, or difficulties in opening the well. Record organic vapor readings with a suitable organic vapor screening device.

- Measure and record the static water level, the depth to the bottom of the well and inside diameter of the well casing. Record these data in the appropriate logbook.

- If using a pressure transducer and data logger (transducers with built-in data loggers are commonly used for slug tests), lower the pressure transducer into the well to a sufficient depth so that the transducer will be below the maximum depth reached by the bottom of the slug bar or other displacement device. If necessary, calibrate the transducer as specified by the manufacturer. Allow the transducer to temperature equilibrate in the well for approximately 15 minutes (or as recommended by the manufacturer) after insertion and prior to any calibration or test procedure to ensure that it will accurately record water level changes. Make sure that the transducer is not placed below its maximum operating depth, or it will not be able to detect any change in pressure. For example, pressure increases 1 pound per square inch (psi) per 2.3 feet of head; therefore, a 10 psi transducer will function to a depth of 23 feet below the water level in the well.

- Secure the pressure transducer cable to the well riser or casing using duct tape. The transducer cable should lay flat along side the well riser, so that disturbance by the slug bar will be minimized. Do not kink the transducer cable, otherwise the pressure equalization vent tube in the cable will be damaged and the transducer will not function properly.

- Allow the water level in the well to recover to static after emplacement of the pressure transducer, prior to starting the test. Measure and record this water level.

- Program the data logger to record logarithmically, with a maximum time interval of no more than 1 minute between readings. If the formation is expected to have low hydraulic conductivity, the maximum interval between readings can be set to a longer time interval, such as 10 minutes.

- Confirm and/or set the transducer and logger parameters as recommended by the manufacturer. This task may also be performed prior to placing the instrument in the well.

- Determine the distance from the top of the well riser to the water surface in the well and add 1 foot to this length. The resulting length is the amount of wire or rope needed so that the slug bar or bailer will be submerged a minimum of 1 foot when it is placed in the well. A loop should be placed in the rope or wire at this length and a strong metal rod or wooden stick placed and secured through the loop. If the bottom of the well is less than this length added to the length of the slug bar or bailer, the length of the rope or wire should be adjusted so that the slug bar will be no less than 1 foot above the top of the pressure transducer when the bar is inserted into the well.

- If depth readings are to be recorded manually (this procedure is not recommended but may be used in formations suspected of having low hydraulic conductivity, less than 1 foot per day), readings should be taken every 10 seconds for the first minute of the test, every 30 seconds for the next 4 minutes and every minute until 10 minutes. Thereafter, readings should be taken every 5 minutes for the duration of the test. If the well has not recovered within 1 hour, readings should be taken every 0.5 hours until 6 hours and 1 hour every hour thereafter. This process will require two personnel during the first 10 minutes of the test: one to act as time keeper/data recorder and one to measure depth to water in the well.

## 5.2 Standard Displacement Slug Tests

### 5.2.1 Falling-Head Slug Test Procedure

This test can only be conducted in wells whose screens are fully submerged, otherwise, displaced water will be introduced into the unsaturated zone and recovery rates will be due to flow in both the unsaturated and saturated zones. All slug test analytical procedures assume flow in the saturated zone only. The following steps must be followed when performing falling-head slug tests:

- Place the slug or bailer in the well until the bottom of the displacement device is no more than 6 inches to 1 foot above the water level in the well. The person holding the device should be holding the rope or wire by the rod or stick described in Section 5.1, ninth bullet.

- Switch on the data recorder, or set the water level meter probe near the level at which water is expected to rise.

- To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly lower the displacement device into the well until the stick or rod is resting horizontally on top of the well riser. The slug bar should not be dropped, in order to minimize sloshing in the well. The data logger is turned on immediately prior to the slug bottom entering the water.

- Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.

- Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.

- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity) the project manager shall be notified and a determination on the well test shall be made.

- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.

- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

***Note:*** Both rising- and falling-head slug tests may be carried out in the same operation by first measuring the rate of water level fall immediately after slug insertion, then measuring the rate of water level rise after slug withdrawal. Be sure that the well has recovered to the static water level before conducting the rising-head test. If using a data logger, the recovery tests needs to be set up and run as a separate test.

### 5.2.2 Rising-Head Slug Test Procedure

The steps for a rising-head test are essentially the same as those for a falling-head test. In a well screened across the water table, a rising-head test is the only test that is valid. The following steps must be followed when performing rising-head slug tests:

- Lower the slug bar or bailer of known volume into the well until it is fully submerged. Allow the well to re-equilibrate to static water level. In formations of suspected low hydraulic conductivity, re-equilibration may take several hours or overnight. In such cases, it is suggested that the displacement device be placed in the well at the end of a field day and the test conducted the following day.

- Turn on the data recorder, if used, or verify that static water level has been re-established with a water level meter.

- To start the test, the person holding the slug bar will signal the person operating the data logger or water level indicator, then rapidly and smoothly raise the displacement device from the well until the bottom of the slug bar is above the water level in the well. The data logger is turned on or manual measurements commence at the moment the slug bar is raised and before it (or any portion of it) is removed from the water. If a data logger is being used, the slug bar wire or rope should be secured to the well casing or riser for the duration of the test and only removed from the well after the test has been completed, in order to avoid disturbing or dislocating the pressure transducer.

- Continue recording depth-time data until the well has recovered to at least 90 percent of the static water level. When using data recorders, it is advisable to check and record the reading every few minutes to ensure that data are being properly recorded. If 90 percent recovery has not occurred within 12 hours, the test may be stopped. Field conditions and time constraints may warrant stopping the test in less than 12 hours. The final decisions under these circumstances will be the responsibility of the field team leader.

- Record the time of test completion in the logbook. If a data recorder with random access memory (RAM) or erasable programmable read only memory (EPROM) was used, record the file name used.

- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity), the project manager shall be notified and a determination on the well test shall be made.

- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.

- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost. If the data were recorded manually, calculate the relative change in head by subtracting the recorded depths to water during recovery from the initial static depth to water reading and record the absolute value of that change, for each depth-time data pair.

## 5.3 Pneumatic Rising-Head Tests
This test can be performed in aquifers of high hydraulic conductivity that are expected to respond very rapidly to slug displacement. It can only be performed in wells where the screen is substantially below the water table, otherwise, increased air pressure in the well casing will be able to bleed off to the unsaturated zone through the well screen and the test will not be successful.

### 5.3.1 Required Equipment
In addition to the required equipment outlined in Section 4.0, the following equipment should be used when conducting a pneumatic rising-head slug test.

- Minimum 30-psi rated transducer and data logger
- Electric water level indicator with on/off switch
- Pressure-tight "tree" assembly, as described below
- Short length (6 inches) of flexible rubber hose whose inside diameter is the same as the outside diameter of the well riser
- Two 2- or 4-inch diameter hose clamps
- Compressor, air pump, or compressed air tank with hose and appropriate adapters

The pressure-tight tree assembly is a device placed on the top of the well that will accomplish the following:

- Form a pressure-tight seal between the well and the atmosphere
- Allow the injection of compressed air into the well via an air hose connected to the pump, compressor, or air supply
- Provide a pressure-tight passage for a pressure transducer cable and a water level meter
- Allow for rapid well depressurization

The tree is illustrated in Figure 1. If the top of the riser is threaded, the device may be screwed onto the riser if the threads are compatible (Teflon™ tape should be used to ensure a good seal). If the threaded end of the riser has been cut off, a slip coupling will need to be placed over the base of the tree and the top of the riser. A small length of flexible rubber hose the same inside diameter as the outside diameter of the coupling will need to be slipped over the coupling and secured in place with tightly closed hose clamps to form a pressure-tight seal between the riser and the well.

The simplest method for providing access through the tree for the pressure transducer cable indicator is to use a modified standard large diameter black rubber cork. A hole the same diameter should be drilled through the cork's axis and a vertical slit should be cut radially from the hole to an edge of the cork. The pressure transducer cable should be threaded through the hole and the water level indicator tape should be placed flat in the slit. The cork should be firmly placed in the top of the tree to form a pressure-tight seal. To ensure that the cork does not pop out while the well is under pressure, it can be secured in place with duct tape or a friction fit plastic cap placed over the cork and onto the tree.

The tree will have a standard ball valve with an inside valve orifice diameter no less than the diameter of the well riser as shown in Figure 1. In addition, a pressure-tight coupling (swage-loc, quick-connect, or Schrader valve) will be attached to the side of the tree to act as a compressed air inlet.

### 5.3.2 Preparation

Preparation procedures for the pneumatic test are similar to those for the standard slug bar displacement test, with the exception that an electronic data logger is a necessity for this procedure.

### 5.3.3 Pneumatic Slug Test Procedure

- Install the test tree to the top of the well, using a method appropriate to the type of riser present (threaded or unthreaded). Make sure that the seal to the riser top is pressure-tight.

- Lower the pressure transducer into the well through the top of the tree to a minimum of 10 feet below the water table. The pressure transducer should be rated no less than 30 psi. Allow the transducer to equilibrate at least 15 minutes prior to initiating any calibration or test procedure.

- Turn on and insert a water level indicator into the well to approximately 5 feet depth below the water table. Turn off the indicator.

- Secure the water level indicator and pressure transducer to the test tree using the rubber cork described in Section 5.3.1. Insert the transducer cable into the hole in the rubber cork via the slit and place the water level indicator tape flat in the slit. Place the cork firmly in the top of the tree so that no gaps are left in the cork. Place small strips of duct tape over the assembly to ensure that the seal is airtight and that the cork cannot loosen when the well is pressurized. During this procedure, do not kink the transducer cable or the pressure equalization vent tube in the cable will be damaged and the transducer will not function.

- Connect the pressure transducer to the data logger and calibrate the system according to manufacturer's instructions. Set the data logger to record logarithmically with a maximum recording interval of no more than 1 minute. Set the logger to record relative change in head only.

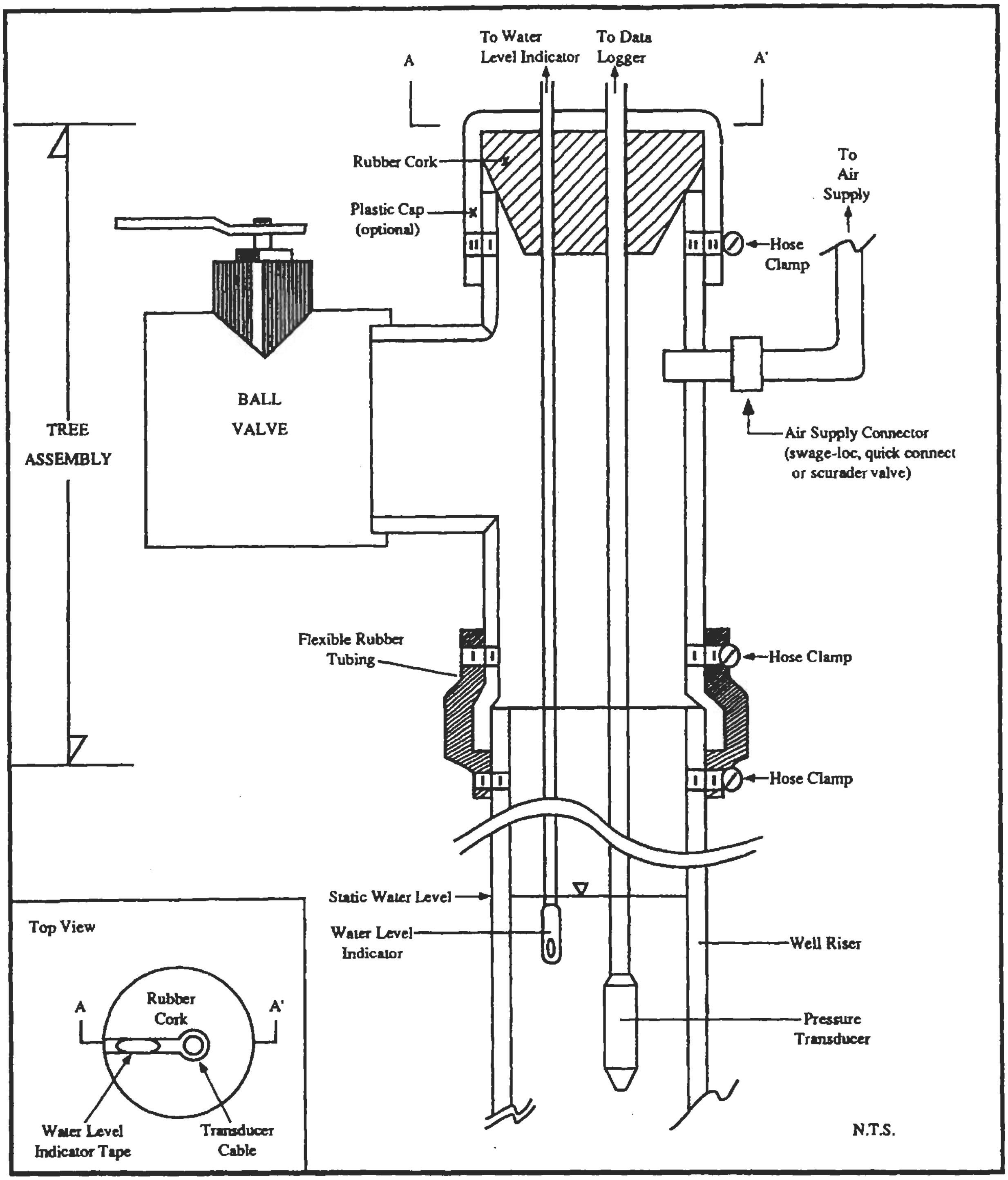
- Connect the air hose to the compressed air supply, pump, or compressor and to the tree. Make sure the ball valve is securely closed.

- Turn on the water level indicator and start feeding compressed air to the well. When the water level in the well has been depressed sufficiently, the water level indicator submergence tone will stop sounding. The pressure required should be no more than 2 or 3 pounds over atmospheric pressure.

- Simultaneously open the ball valve and activate the data logger. Open the ball valve quickly so that the pressure is released at once.

- In highly permeable aquifers, the water level should recover to pre-test water levels within a few seconds. Full recovery should be accomplished in no more than 1 minute. In any event, do not stop the test until a minimum of 90 percent recovery can be confirmed by interrogating the data logger.

## Figure 1 - Pneumatic Slug Test "Tree" Schematic



- Review the response curve. If a sufficient response curve was not recorded (e.g., logging was not started soon enough to identify maximum water level displacement), then the test shall be repeated. If an acceptable response curve is not being recorded due to field conditions (e.g., no water level response due to high hydraulic conductivity) the project manager shall be notified and a determination on the well test shall be made.

- Record the time of test completion in the logbook. If a data recorder with RAM or EPROM was used, record the file name used.

- Decontaminate all equipment according to SOP 4-5. Clean up the site, and close and lock the well before leaving. Contaminated plastic sheeting and disposable protective clothing should be taken to designated disposal containers.

- Download the data logger to a computer or to hardcopy to ensure that the data is not inadvertently lost.

# 6.0 Data Reduction and Analysis Procedures

## 6.1 General

The following slug test data reduction procedure and report is recommended.

- All raw data should be printed out and listed as an appendix to the analysis report.

- All data should be plotted using the graphing method of the accepted analytical solution. These plots should be included as an appendix to the analysis report.

- All well geometry data should be tabulated and included in the analysis report. Most of these data must be known prior to the start of testing, except for items related to the water level in the well at the time of testing. The purpose of this tabulation is to ensure consistent calculation of all variables required in the data analysis, make input into a data analysis computer program an easier task, and to make technical review of the analyses and input values easier. This table should include the following items for each tested well or piezometer (the list of items may vary depending on the analytical method employed):

    - Well ground surface elevation
    - Well reference elevation (i.e., top of riser)
    - Depth to static water level at start of test
    - Elevation of static water level at start of test
    - Depth to top of screen or open interval from ground surface or top of casing
    - Depth to bottom of screen or open interval from ground surface or top of casing
    - Elevation of top of screen or open interval
    - Elevation of bottom of screen or open interval
    - Depth to base of aquifer (if available)
    - Elevation of base of aquifer (if available)
    - Aquifer saturated thickness
    - Depth to top of screen or open interval relative to the top of the aquifer
    - Depth to bottom of screen or open interval relative to the top of the aquifer
    - Length of saturated well screen
    - Length of saturated riser
    - Diameter of well riser and screen (or open interval)
    - Diameter of borehole
    - Grain-size of filter pack

- The report should include a detailed description of the data collection procedures and test methods.

- The report should include a detailed listing of all analysis results.

- When reviewing the data for analysis, note that if the water level recovered to the static level (or close to it) before the test was stopped, only the data prior to 100 percent recovery should be included in the data plot. Plotting 100 minutes of data when the recovery occurred over 30 seconds or 2 minutes will make analysis of the actual response very difficult and often lead to a substantial underestimate of the formation hydraulic conductivity. Raw data plots should also be examined for evidence of sloshing of the water level in the well caused by insertion or removal of the slug bar. In most cases, these early data points can also be removed from the data set and time values reset to the new starting point represented by the remaining data. This evaluation is shown on Figure 2. The data may also be removed using common software packages developed for analyzing slug tests.

### 6.2 Review and Analysis of Data

Slug test response generally falls into three categories illustrated on Figure 3. Overdamped or normal response occurs where the well recovers to static level without exceeding that level. Critically damped response occurs where the well recovers to static level and the water level flows above (rising-head test) or below (falling-head test) then recovers to static in a sinusoidal manner within one cycle, as shown in Figure 3. The third category is underdamped harmonic oscillatory response, where the water level in the well oscillates around the static water level as a sine wave of decreasing amplitude.

Slug test data are recommended to be analyzed with computer software; however, data may also be analyzed manually. The CDM groundwater modeling tool kit contains Aquifer$^{WIN32}$, which is a program that may be used for analyzing slug test data. Other programs are also available. Software packages are useful since they can be used to manage a significant amount of data in short time periods and contain many different confined and unconfined slug test solutions. The trained user can use these benefits to generate detailed response curve graphs, precise hydraulic conductivity values, and insights into the hydrogeologic framework near the well. Regardless of the analytical method employed or whether the data is analyzed manually or by computer, the analyst should review the original technical paper or textbook summary of the method in order to understand the mechanics and assumptions underlying the method prior to attempting any analysis.

Slug test data analyses and hydraulic conductivity calculations shall be performed by an experienced professional. Data analysis and parameter calculations are beyond the scope of this SOP and, therefore, are not discussed here.

## 7.0 Restrictions and Limitations

In wells in which the static water level and water levels induced during testing are above the top of the screened or open hole interval, both rising-head and falling-head tests should be conducted to provide a redundancy check of results. However, in most cases, rising-head tests provide more consistent data, less subject to sloshing of the water level due to displacement by the slug bar than is often observed in falling-head tests.

Falling-head slug tests are invalid in wells where the static water level is at or below the top of the screened or open-hole interval.

Regardless of which testing method is used, it is recommended that the hydraulic conductivity testing be performed three times in each well, if time constraints such as recovery time or the project schedule will allow multiple tests. The purpose of multiple testing is to demonstrate the precision of the test results. Ideally, the test results will be similar, which results in an increased level of confidence in the data. In addition, if one of the data sets is bad, there is additional data available for analysis.

## 8.0 References

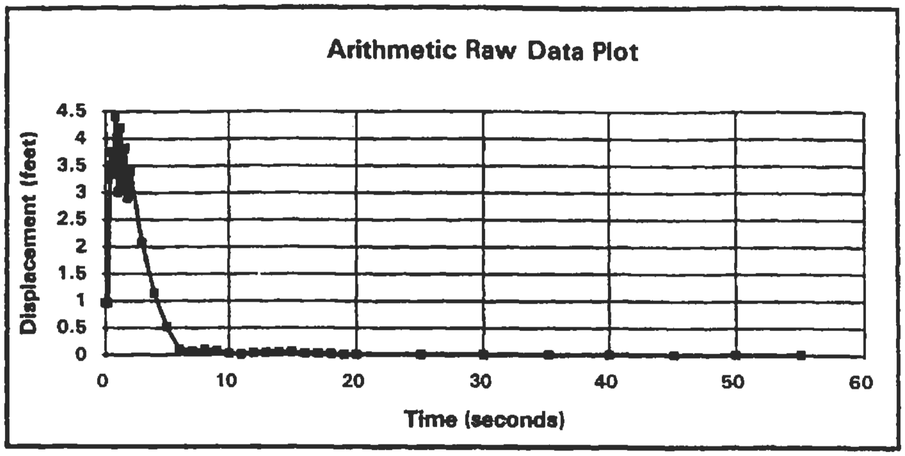
American Society for Testing and Materials. 2002. *Standard Test Method (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers*.

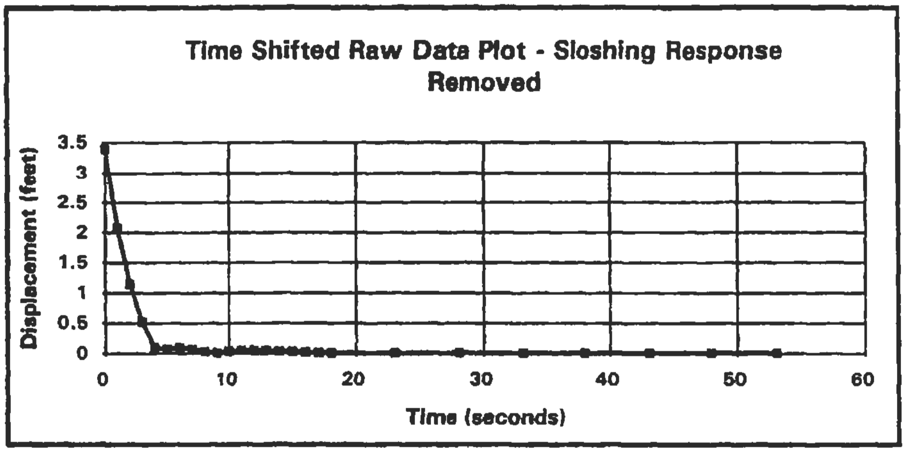
Environmental Simulations, Inc. 2000. *Guide to Using Aquifer$^{WIN32}$*.

U. S. Environmental Protection Agency. 1987. *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001.

__________. 1996. Region 4. *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.*

**Figure 2 - Deletion of Nonessential Data**



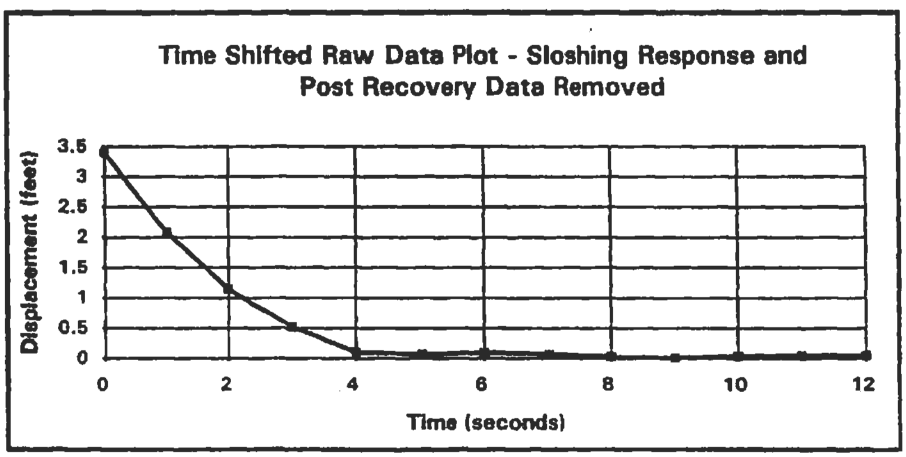
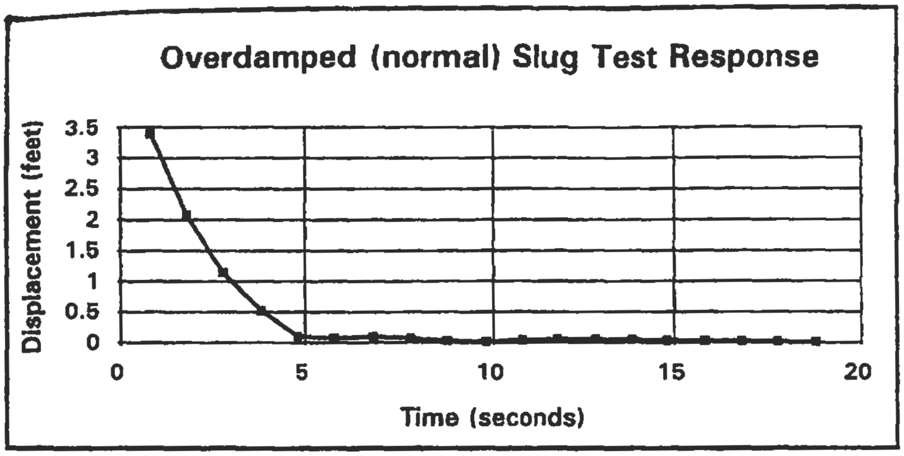
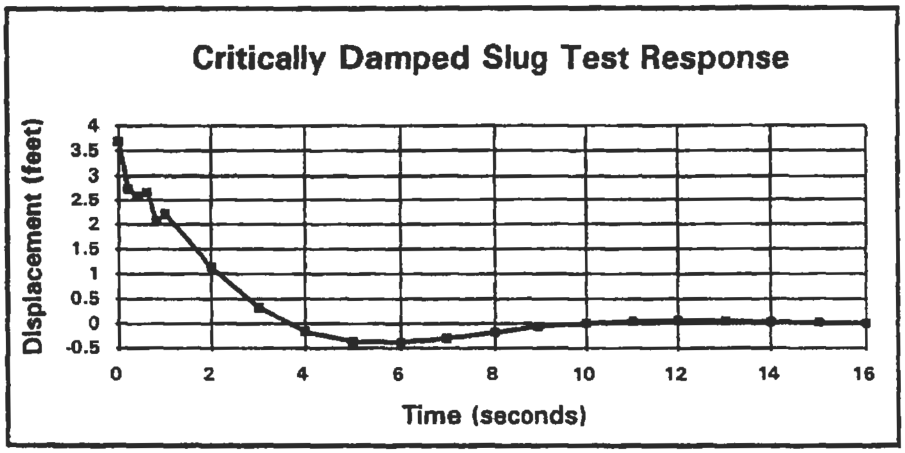
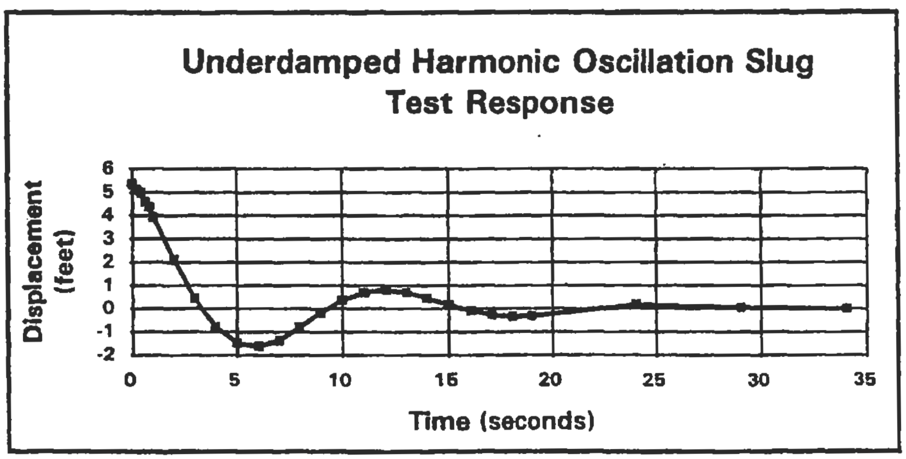



**Figure 3 - Typical Slug Test Responses**



# Control of Measurement and Test Equipment

SOP 5-1
Revision: 7
Date: December 31, 2004

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|---|---|---|---|
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| **Issued:** | 12/28/04 | | Signature/Date |
| | Signature/Date | | |

## 1.0 Objective

The objective of this standard operating procedure (SOP) is to establish the baseline requirements, procedures, and responsibilities inherent to the control and use of all measurement and test equipment (M&TE). Contractual obligations may require more specific or stringent requirements that must also be implemented.

## 2.0 Background

### 2.1 Definitions

**Traceability -** The ability to trace the history, application, or location of an item and like items or activities by means of recorded identification.

### 2.2 Discussion

M&TE may be government furnished (GF), rented or leased from an outside vendor, or purchased. It is essential that measurements and tests resulting from the use of this equipment be of the highest accountability and integrity. To facilitate that, the equipment shall be used in full understanding and compliance with the instructions and specifications included in the manufacturer's operations and maintenance and calibration procedures and in accordance with any other related project-specific requirements.

### 2.3 Associated Procedures

- CDM Federal (CDM) Technical SOP 4-1
- CDM Quality Procedures (QPs) 2.1 and 2.3
- Manufacturer's operating and maintenance and calibration procedures

## 3.0 Responsibilities

All staff with responsibility for the direct control and/or use of M&TE are responsible for being knowledgeable of and understanding and implementing the requirements contained herein as well as any other related project-specific requirements.

The project manager (PM) or designee (equipment coordinator, quality assurance coordinator, field team leader, etc.) is responsible for initiating and tracking the requirements contained herein.

## 4.0 Required Equipment

- Determine and implement M&TE related project-specific requirements
- The maintenance and calibration procedures must be followed when using M&TE
- Obtain the maintenance and calibration procedures if they are missing or incomplete
- Attach or include the maintenance and calibration procedures with the M&TE
- Prepare and record maintenance and calibration in an Equipment Log or a Field Log as appropriate (Figure 1)
- Maintain M&TE records
- Label M&TE requiring routine or scheduled calibration (when required)
- Perform maintenance and calibration using the appropriate procedure and calibration standards
- Identify and take action on nonconforming M&TE

# 5.0 Procedures

## 5.1 Determine if Other Related Project-Specific Requirements Apply

**For All M&TE:**
The PM or designee shall determine if M&TE related project-specific requirements apply. If M&TE related project-specific requirements apply, obtain a copy of them and review and implement as appropriate.

## 5.2 Obtain the Operating and Maintenance and Calibration Documents

**For GF M&TE that is to be procured**:
**Requisitioner** - Specify that the maintenance and calibration procedures be included.

**For GF M&TE that is acquired as a result of a property transfer:**
**Receiver** - Inspect the M&TE to determine whether maintenance and calibration procedures are included with the item. If missing or incomplete, order the appropriate documentation from the manufacturer.

**For M&TE that is to be rented or leased from an outside vendor:**
**Requisitioner** - Specify that the maintenance and calibration procedures, the latest calibration record, and the calibration standards certification be included. If this information is not delivered with the M&TE, ask Procurement to request it from the vendor.

## 5.3 Prepare and Record Maintenance and Calibration Records

**For all M&TE:**
**PM or Designee** - Record all maintenance and calibration events in a Field Log unless other project-specific requirements apply.

**For GF M&TE only (does not apply to rented or leased M&TE):**
If an Equipment Log is a project specific requirement, perform the following:

**Receiver** - Notify the PM or designee for the overall property control of the equipment of the receipt of an item of M&TE.

**PM or Designee** - Prepare a sequentially page numbered Equipment Log for the item using the maintenance and calibration form (or equivalent) from the CDM *Property Control Manual* (Figure 1).

**PM or Designee and User** - Record all maintenance and calibration events in an Equipment Log.

## 5.4 Label M&TE Requiring Calibration

**For GF M&TE only (does not apply to rented or leased M&TE):**
If calibration labeling is a project specific requirement, perform the following:

**PM or Designee** - Read the maintenance and calibration procedures to determine the frequency of calibration required.

**PM or Designee** - If an M&TE item requires calibration before use, affix a label to the item stating "Calibrate Before Use."

**PM or Designee** - If an M&TE item requires calibration at other scheduled intervals, e.g., monthly, annually, etc., affix a label listing the date of the last calibration, the date the item is next due for a calibration, the initials of the person who performed the calibration, and a space for the initials of the person who will perform the next calibration.

## 5.5 Operating, Maintaining or Calibrating an M&TE Item

**For all M&TE:**
**PM or Designee and User** - Operate, maintain, and calibrate M&TE in accordance with the maintenance and calibration procedures. Record maintenance and calibration actions in the Equipment Log or Field Log.

**Figure 1**

CDM
A subsidiary of Camp Dresser & McKee Inc.

## Maintenance and Calibration

Date: ____________________ Time: ________ (AM/PM)

Employee Name: ____________________ Equipment Description: ____________________

Contract/Project: ____________________ Equipment ID No.: ____________________

Activity: ____________________ Equipment Serial No.: ____________________

**Maintenance**

Maintenance Performed:

Comments:

Signature: ____________________ Date: ____________________

**Calibration/Field Check**

Calibration Standard: ____________________ Concentration of Standard: ____________________

Lot No. of Calibration Standard: ____________________ Expiration Date of Calibration Standard: ____________________

Pre-Calibration Reading: ____________________ Post-Calibration Reading: ____________________

Additional Readings: ____________________ Additional Readings: ____________________

Additional Readings: ____________________ Additional Readings: ____________________

Pre-Field Check Reading: ____________________ Post-Field Check Reading: ____________________

Adjustment(s):

Calibration: ☐ Passed ☐ Failed

Comments:

Signature: ____________________ Date: ____________________

## 5.6 Shipment

**For GF M&TE:**

**Shipper** - Inspect the item to ensure that the maintenance and calibration procedures are attached to the shipping case, or included, and that a copy of the most recent Equipment Log entry page (if required) is included with the shipment. If the maintenance and calibration procedures and/or the current Equipment Log page (if required) is missing or incomplete, do not ship the item. Immediately contact the PM or designee and request a replacement.

**For M&TE that is rented or leased from an outside vendor:**

**Shipper** - Inspect the item to ensure that the maintenance and calibration procedures and latest calibration and standards certification records are included prior to shipment. If any documentation is missing or incomplete, do not ship the item. Immediately contact Procurement and request that they obtain the documentation from the vendor.

## 5.7 Records Maintenance

**For GF M&TE:**

**PM or Designee** - Create a file upon the initial receipt of an item of M&TE or calibration standard. Organize the files by contract origin and by M&TE item and calibration standard. Store all files in a cabinet, file drawer, or other appropriate storage media at the pertinent warehouse or office location.

**PM or Designee** - Maintain all original documents in the equipment file except for the packing slip and Field Log.

**Receiver** - Forward the original packing slip to Procurement and a photocopy to the PM or designee.

**PM or Designee** - File the photocopy of the packing slip in the M&TE file.

**PM or Designee and User** - Record all maintenance and calibration in an Equipment Log or Field Log (as appropriate.) File the completed Equipment Logs in the M&TE records. Forward completed Field Logs to the PM for inclusion in the project files.

**For M&TE rented or leased from an outside vendor:**

**Receiver** - Forward the packing slip to Procurement.

**User** - Forward the completed Field Log to the PM for inclusion in the project files.

**User** - Retain the most current maintenance and calibration record and calibration standards certifications with the M&TE item and forward previous versions to the PM for inclusion in the project files.

## 5.8 Traceability of Calibration Standards

**For all items of M&TE:**

**PM or Designee and User** - When ordering calibration standards, request nationally recognized standards as specified or required. Request commercially available standards when not otherwise specified or required. Or, request standards in accordance with other related project-specific requirements.

**PM or Designee and User** - Require certifications for standards that clearly state the traceability.

**PM or Designee and User** - Note standards that are perishable and consume or dispose of them on or before the expiration date.

**PM or Designee** - Require Material Safety Data Sheet to be provided with standards.

# Appendix C
# Public Benefit Information

LAW OFFICES

CORETTE POHLMAN & KEBE

A PROFESSIONAL CORPORATION

Mayer Building
129 West Park Street
P.O. Box 509
Butte, Montana 59703

Telephone (406) 782-5800
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DOLPHY O. POHLMAN
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DANIEL D. MANSON
TIMOTHY M. DICK
AMBER L. SUMMERS

HOWARD A. JOHNSON (1895-1974)
ROBERT D. CORETTE (1911-1989)
KENDRICK SMITH (1905-1989)

Of Counsel:
KEITH P. JOHNSON

## FACSIMILE TRANSMISSION

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TO: Jane Amdahl

FACSIMILE MACHINE PHONE : 444-1901

FROM: Dan Manson

DATE: 7/18/03

NUMBER OF PAGES (Including Cover Sheet): 4

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MESSAGE: Berg Estate

| | |
|---|---|
| DATE SENT: | FAX OPERATOR: |
| NAME OF CASE: | |
| CASE NUMBER: | |

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KENDRICK SMITH (1905-1989)

Of Counsel:
KEITH P. JOHNSON

July 18, 2003

Ms. Jane Amdahl
Montana Department of Environmental Quality
2209 Phoenix
P.O. Box 200901
Helena, MT 59620-0901

**SENT VIA FAX (406) 444-1901**

Re: Bankruptcy Estate of George Berg
Brownfields Assessment Application
Our file: 9221-T0312

Dear Ms. Amdahl:

The purpose of this letter is to address the "public benefit" requirement needed to qualify for a grant under the Brownfield Assessment program. Based upon our conversations, it is our understanding that the former Berg Lumber facility will qualify for a Brownfield Assessment grant provided the Bankruptcy Estate can provide a sufficient public benefit to qualify for the grant.

For purposes of the public benefit, the Bankruptcy Estate would be willing to offer a permanent public access easement across Estate property to Spring Creek. As you may know, Spring Creek is a blue-ribbon trout stream and a very important natural resource to Lewistown and the surrounding area. For purposes of illustration, we are enclosing a copy of Certificate of Survey No. 495. For your reference in location, the property is partially composed of the sawdust pile which is being removed by the Estate. As you can see, Tract 1, which is 5.849 acres provides direct access to the stream in two locations and also borders a public road at its Northwest corner. We would propose granting an easement over and across all of Tract 1 for recreational and fishing access.

We have met with the Fergus County Commissioners about this issue and they are excited about the idea. They would rather have the easement than direct ownership of the property. We advised them we would be willing to do either. The Commissioners are willing to speak with the EPA or write a letter to EPA voicing their support for the project.

We believe that this project is very beneficial to both the public and the environment. It will provide extra money to characterize the waste on the site and allow the Estate to preserve its resources for the actual cleanup. It will also provide the public with another access point to the stream.

If you have any questions or need clarification of any issues, please contact our office. As we discussed, the grant of an easement will be subject to approval of the Bankruptcy Court. As soon as you advise us that the project is approved by EPA, we will petition the Bankruptcy Court for approval.

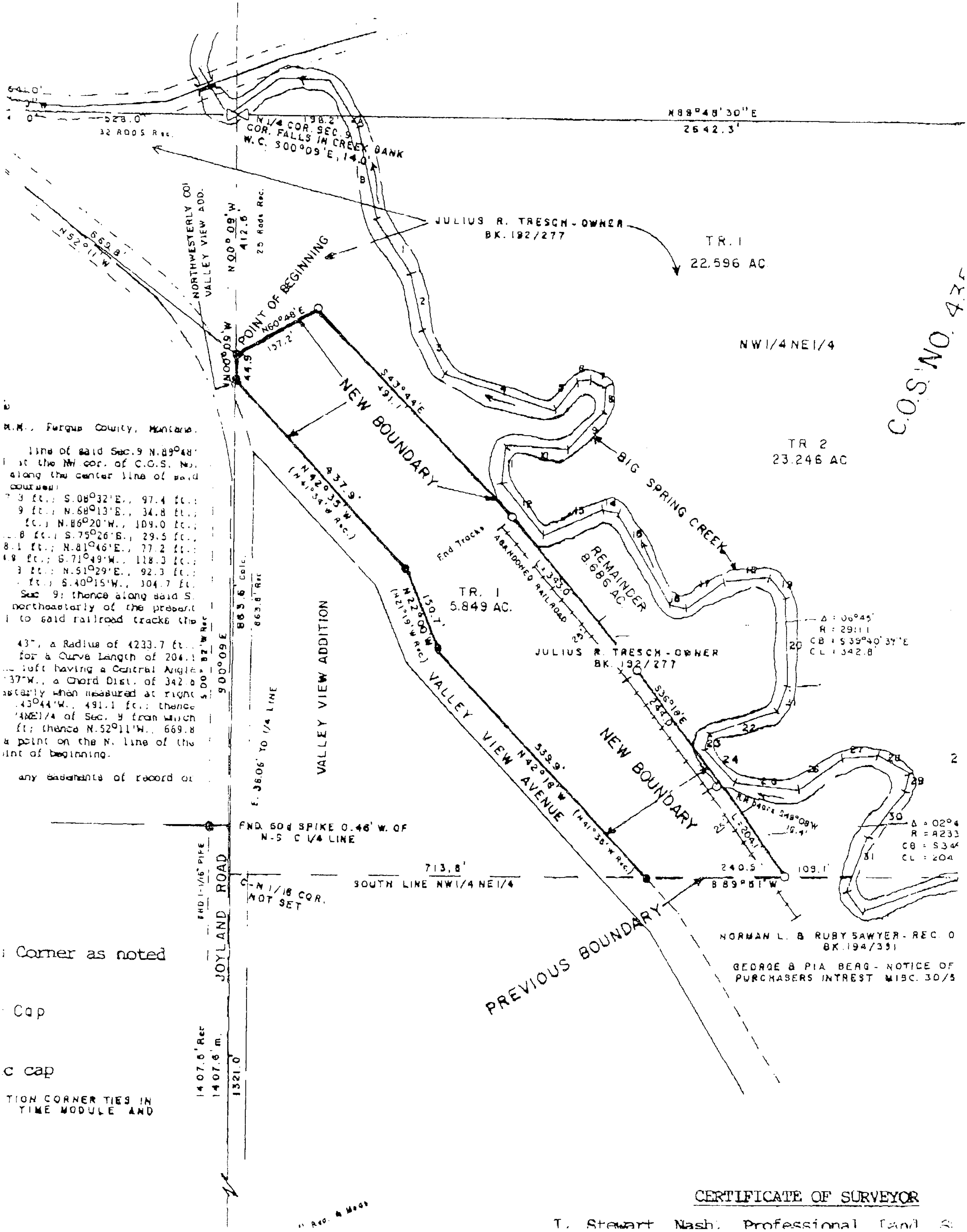
We look forward to working with you on this project.

Very truly yours,

CORETTE POHLMAN & KEBE

By Dan Manson
Daniel D. Manson

enc.




M.M., Fergus County, Montana.

line of said Sec. 9 N.89°48'
at the NW cor. of C.O.S. No.
along the center line of said
courses:
3 ft.; S.08°32'E., 97.4 ft.;
9 ft.; N.68°13'E., 34.8 ft.;
ft.; N.86°20'W., 109.0 ft.;
.8 ft.; S.75°26'E., 29.5 ft.;
8.1 ft.; N.81°46'E., 77.2 ft.;
4.8 ft.; S.71°49'W., 118.3 ft.;
3 ft.; N.51°29'E., 92.3 ft.;
ft.; S.40°15'W., 304.7 ft.
Sec. 9; thence along said S.
northeasterly of the present
to said railroad tracks the

43", a Radius of 4233.7 ft.
for a Curve Length of 204.1
left having a Central Angle
37"W., a Chord Dist. of 342.8
asterly when measured at right
43°44'W., 491.1 ft.; thence
NE1/4 of Sec. 9 from which
ft; thence N.52°11'W., 669.8
a point on the N. line of the
int of beginning.

any easements of record or

Corner as noted

Cap

c cap

TION CORNER TIES IN
TIME MODULE AND

CERTIFICATE OF SURVEYOR

T. Stewart Nash, Professional Land S

# Appendix D
# Individual Boring & Test Pit Parameters and Forms

# Tier 1 Sampling

## Sampling Parameters for BL-BH01

| Depth (feet) | Standard Split Spoon | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|---|
| 0 | X | X | X | X | | |
| 2 | X | X | X | X | | |
| 5 | X | X | | | | |
| 10 | X | X | X | X | | |
| 20 | X | X | | | | |
| 30 | X | X | X | X | | |

Notes:

## Sampling Parameters for BL-BH02

| Depth (feet) | Standard Split Spoon | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|---|
| 0 | X | X | X | X | | |
| 2 | X | X | X | X | | |
| 5 | X | X | | | | |
| 10 | X | X | X | X | | |
| 20 | X | X | | | | |
| 30 | X | X | X | X | | |

Notes:

## Sampling Parameters for BL-BH03

| Depth (feet) | Standard Split Spoon | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|---|
| 0 | X | X | X | X | | |
| 2 | X | X | X | X | | |
| 5 | X | X | | | | |
| 10 | X | X | X | X | | |
| 20 | X | X | | | | |
| 30 | X | X | X | X | | |

Notes:

## Sampling Parameters for BL-BH04

| Depth (feet) | Standard Split Spoon | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|---|
| 0 | X | X | X | X | | |
| 2 | X | X | X | X | | X |
| 5 | X | X | | | | |
| 10 | X | X | X | X | | |
| 20 | X | X | | | | |
| 30 | X | X | X | X | | |

Notes:

### Sampling Parameters for BL-BH05

| Depth (feet) | Standard Split Spoon | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|---|
| 0 | X | X | X | X | | |
| 2 | X | X | X | X | | |
| 5 | X | X | | | | |
| 10 | X | X | X | X | | |
| 20 | X | X | | | | |
| 30 | X | X | X | X | | |

Notes:

### Sampling Parameters for BL-BH06

| Depth (feet) | Standard Split Spoon | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|---|
| 0 | X | X | X | X | | |
| 2 | X | X | X | X | | |
| 5 | X | X | | | | |
| 10 | X | X | X | X | | |
| 20 | X | X | | | | |
| 30 | X | X | X | X | | |

Notes:

**Sampling Parameters for BL-MW05**

| Depth (feet) | Standard Split Spoon | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|---|
| 0 | X | X | X | X | | |
| 2 | X | X | X | X | | |
| 5 | X | X | | | | |
| 10 | X | X | X | X | | X |
| 20 | X | X | | | | |
| 30 | X | X | X | X | | |

Notes:

**Sampling Parameters for BL-TP01**

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

**Sampling Parameters for BL-TP02**

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

**Sampling Parameters for BL-TP03**

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP04

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP05

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP06

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP07

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP08

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP09

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

### Sampling Parameters for BL-TP10

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

### Sampling Parameters for BL-TP11

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | X |

Notes:

### Sampling Parameters for BL-TP12

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP13

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP14

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP15

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | | |
| 6-24 | X | X | X | | |

Notes:

## Sampling Parameters for BL-TP16

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | X | X | X | X | |
| 6-24 | X | X | X | X | |

Notes:

# Tier 2 Sampling

## Sampling Parameters for BL-TP17

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | X | |
| 6-24 | | | X | X | |

Notes:

## Sampling Parameters for BL-TP18

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP19

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP20

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP21

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

### Sampling Parameters for BL-TP22

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

### Sampling Parameters for BL-TP23

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

### Sampling Parameters for BL-TP24

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | X | |
| 6-24 | | | X | X | |

Notes:

## Sampling Parameters for BL-TP25

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | X |

Notes:

## Sampling Parameters for BL-TP26

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP27

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP28

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP29

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP30

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP31

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

## Sampling Parameters for BL-TP32

| Depth (inches) | PCP | Dioxin/Furan | EPH Screen | VPH | Duplicate |
|---|---|---|---|---|---|
| 0-6 | | | X | | |
| 6-24 | | | X | | |

Notes:

# Forms

CDM

WELL NO. ________

Total Depth ________

Sheet ________ of ________

# WELL DRILLING AND INSTALLATION LOG

LOCATION SKETCH

Surface Elevation: ________

Elevation Datum: ________

| | | | | | |
|---|---|---|---|---|---|
| Project: | | Start Drilling: | Time: | Date: | |
| Project Manager: | Project No.: | Complete Drilling: | Time: | Date: | |
| Logged By: | Edited By: | Start Installation | Time: | Date: | |
| Drilling Contractor: | Driller's Name: | Complete Installation: | Time: | Date: | |
| Sampling Methods: | | Date | Time | Depth to Water | Completion Designation |
| Drill Rig Type: | | | | | |
| Casing Type and Diam.: | | | | | |
| Hammer Weight: | Drop: | | | | |
| Surface Conditions: | | | | | |

| Well Installation Notes | Details of Well Construction | Depth in feet | USCS | Soil Description | Sample Depth | Sample Type | Blows per 0.5 feet | Feet Driven | Feet Recovered | Sample Condition | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | +1 | | | | | | | | | | |
| | | 0 | | | | | | | | | | |
| | | 1 | | | | | | | | | | |
| | | 2 | | | | | | | | | | |
| | | 3 | | | | | | | | | | |
| | | 4 | | | | | | | | | | |
| | | 5 | | | | | | | | | | |
| | | 6 | | | | | | | | | | |
| | | 7 | | | | | | | | | | |
| | | 8 | | | | | | | | | | |
| | | 9 | | | | | | | | | | |

CDM

# WELL DRILLING AND INSTALLATION LOG

WELL NO. ________

Sheet ________ of ________

| Well Installation Notes | Details of Well Construction | Depth in feet | USCS | Soil Description | Sample Depth | Sample Type | Blows per 0.5 feet | Feet Driven | Feet Recovered | Sample Condition | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |

Rev.01/02

# Appendix E
# Risk-Based Screening Levels for Soil and Groundwater

# TABLE 1
## TIER 1 SURFACE SOIL (0-2 ft) RBSLs (mg/kg)
## (includes default RBSLs)

This table applies to contaminated surface soil from 0-2 feet below ground surface. **For VPH compounds at UST sites, default RBSLs (bold) are used to determine if a release has occurred at a site. Default RBSLs apply to the entire soil column and always apply in the absence of adequate information. For EPH compounds the 50 ppm screening level is used to determine whether a release has occurred at UST sites.** Distance to water is from the sample depth to the water table.

| **Distance to groundwater** | | **< 10 feet to groundwater** | | | | **10-20 feet to groundwater** | | | | **> 20 feet to groundwater** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chemical** | **E** | **Residential** | **B** | **Commercial** | **B** | **Residential** | **B** | **Commercial** | **B** | **Residential** | **B** | **Commercial** | **B** |
| **For Gasoline and Light Hydrocarbons measured using the Massachusetts Method for Volatile Petroleum Hydrocarbons (VPH)** | | | | | | | | | | | | | |
| C5-C8 Aliphatics | n | **10** | dc | 50 | dc | 10 | dc | 50 | dc | 10 | dc | 50 | dc |
| C9-C12 Aliphatics | n | **70** | dc | 300 | dc | 70 | dc | 300 | dc | 70 | dc | 300 | dc |
| C9-C10 Aromatics | n | **8** | l | 8 | l | 10 | dc | 30 | l | 10 | dc | 40 | l |
| MTBE | n | **0.1** | l | 0.1 | l | 0.2 | l | 0.2 | l | 0.3 | l | 0.3 | l |
| Benzene | c | **0.05** | l | 0.05 | l | 0.1 | l | 0.1 | l | 0.2 | l | 0.2 | l |
| Toluene | n | **10** | l | 10 | l | 40 | l | 40 | l | 60 | l | 60 | l |
| Ethylbenzene | n | **10** | l | 10 | l | 40 | l | 40 | l | 60 | l | 60 | l |
| Xylenes | n | **20** | dc | 80 | dc | 20 | dc | 80 | dc | 20 | dc | 80 | dc |
| Naphthalene | n | **9** | l | 9 | l | 30 | l | 30 | l | 50 | l | 50 | l |
| **For Diesel and Heavy Hydrocarbons measured using the Massachusetts Method for Extractable Petroleum Hydrocarbons (EPH)** | | | | | | | | | | | | | |
| C9-C18 Aliphatics | n | 100 | dc | 600 | dc | 100 | dc | 600 | dc | 100 | dc | 600 | dc |
| C19-C36 Aliphatics | n | 2,500 | bu | 5,000 | bu | 2,500 | bu | 5,000 | bu | 2,500 | bu | 5,000 | bu |
| C11-C22 Aromatics | n | 70 | dc | 100 | l | 70 | dc | 300 | dc | 70 | dc | 300 | dc |
| Acenaphthene | n | 200 | l | 200 | l | 500 | l | 500 | l | 600 | dc | 800 | l |
| Anthracene | n | 3,000 | dc | 4,000 | l | 3,000 | dc | 10,000 | l | 3,000 | dc | 20,000 | l |
| Benz(a)anthracene | c | 0.8 | dc | 6 | dc | 0.8 | dc | 6 | dc | 0.8 | dc | 6 | dc |
| Benzo(a)pyrene | c | 0.08* | dc | 0.6 | dc | 0.08* | dc | 0.6 | dc | 0.08* | dc | 0.6 | dc |
| Benzo(b)fluoranthene | c | 0.8 | dc | 6 | dc | 0.8 | dc | 6 | dc | 0.8 | dc | 6 | dc |
| Benzo(k)fluoranthene | c | 8 | dc | 60 | dc | 8 | dc | 60 | dc | 8 | dc | 60 | dc |
| Chrysene | c | 80 | dc | 600 | dc | 80 | dc | 600 | dc | 80 | dc | 600 | dc |
| Dibenzo(a,h)anthracene | c | 0.08* | dc | 0.6 | dc | 0.08* | dc | 0.6 | dc | 0.08* | dc | 0.6 | dc |
| Fluoranthene | n | 400 | dc | 1,000 | l | 400 | dc | 4,000 | l | 400 | dc | 5,000 | l |
| Fluorene | n | 200 | l | 200 | l | 400 | dc | 600 | l | 400 | dc | 900 | l |
| Indeno(1,2,3-cd)pyrene | c | 0.8 | dc | 6 | dc | 0.8 | dc | 6 | dc | 0.8 | dc | 6 | dc |
| Naphthalene | n | 9 | l | 9 | l | 30 | l | 30 | l | 50 | l | 50 | l |
| Pyrene | n | 300 | dc | 5,000 | l | 300 | dc | 6,000 | dc | 300 | dc | 6,000 | dc |

Notes:

E = Effect is either: n = non-carcinogenic and direct contact RBSLs are based on a hazard quotient of 0.125 for a total hazard index which does not exceed 1, or
c = carcinogenic and direct contact RBSLs are based on a cancer risk of $1X10^{-6}$ for a total cancer risk which does not exceed $1X10^{-5}$.

B = Basis is the most conservative of: l = leaching from soil to groundwater;
dc = residential direct contact including ingestion, inhalation, and dermal; or
bu = adversely affects beneficial uses (foul odor or taste).

If the leaching pathway is not the most conservative basis, residential or commercial RBSLs apply to surface soil.

* = The best achievable practical quantitation limit (0.33) is greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

**DEQ's RBCA policy includes a ceiling concentration of 100 mg/kg for the total of the gasoline range fractions and 2,500 mg/kg for the total of the diesel range fractions in residential soil.**

**DEQ's RBCA policy includes a ceiling concentration of 500 mg/kg for the total of the gasoline range fractions and 5,000 mg/kg for the total of the diesel range fractions in commercial soil.**

## TABLE 2
## TIER 1 SUBSURFACE SOIL (>2 ft) RBSLs (mg/kg)

This table applies to contaminated subsurface soil (>2 feet below the ground surface). Distance to water is from the sample depth to the water table. **For VPH compounds at UST sites, default RBSLs, provided in bold on Table 1, are used to determine if a release has occurred at a site. Default RBSLs apply to the entire soil column and always apply in the absence of adequate information. For EPH compounds the 50 ppm screening level is used to determine whether a release has occurred at UST sites.**

| Distance to groundwater | | < 10 feet to ground water | | 10-20 feet to ground water | | > 20 feet to ground water | |
|---|---|---|---|---|---|---|---|
| **Chemical** | **E** | **>2 ft Excavation** | **B** | **>2 ft Excavation** | **B** | **>2 ft Excavation** | **B** |
| **For Gasoline and Light Hydrocarbons measured using the Massachusetts Method for Volatile Petroleum Hydrocarbons (VPH)** | | | | | | | |
| C5-C8 Aliphatics | n | 100 | dc | 100 | dc | 100 | dc |
| C9-C12 Aliphatics | n | 500 | bu | 500 | bu | 500 | bu |
| C9-C10 Aromatics | n | 8 | l | 30 | l | 40 | l |
| MTBE | n | 0.1 | l | 0.2 | l | 0.3 | l |
| Benzene | c | 0.05 | l | 0.1 | l | 0.2 | l |
| Toluene | n | 10 | l | 40 | l | 60 | l |
| Ethylbenzene | n | 10 | l | 40 | l | 60 | l |
| Xylenes | n | 200 | dc | 200 | dc | 200 | dc |
| Naphthalene | n | 9 | l | 30 | l | 50 | l |
| **For Diesel and Heavy Hydrocarbons measured using the Massachusetts Method for Extractable Petroleum Hydrocarbons (EPH)** | | | | | | | |
| C9-C18 Aliphatics | n | 1,000 | dc | 1,000 | dc | 1,000 | dc |
| C19-C36 Aliphatics | n | 5,000 | bu | 5,000 | bu | 5,000 | bu |
| C11-C22 Aromatics | n | 100 | l | 400 | l | 600 | l |
| Acenaphthene | n | 200 | l | 500 | l | 800 | l |
| Anthracene | n | 4,000 | l | 10,000 | l | 20,000 | l |
| Benz(a)anthracene | c | 10 | l | 40 | l | 70 | l |
| Benzo(a)pyrene | c | 3 | l | 10 | l | 20 | l |
| Benzo(b)fluoranthene | c | 50 | l | 200 | l | 200 | dc |
| Benzo(k)fluoranthene | c | 500 | l | 2,000 | l | 2,000 | dc |
| Chrysene | c | 1,000 | l | 5,000 | l | 8,000 | l |
| Dibenzo(a,h)anthracene | c | 6 | l | 20 | dc | 20 | dc |
| Fluoranthene | n | 1,000 | l | 4,000 | l | 5,000 | l |
| Fluorene | n | 200 | l | 600 | l | 900 | l |
| Indeno(1,2,3-cd)pyrene | c | 10 | l | 40 | l | 60 | l |
| Naphthalene | n | 9 | l | 30 | l | 50 | l |
| Pyrene | n | 5,000 | l | 7,000 | dc | 7,000 | dc |

Notes:

E = Effect is either: n = non-carcinogenic and direct contact RBSLs are based on a hazard quotient of 0.125 for a total hazard index which does not exceed 1, or

c = carcinogenic and direct contact RBSLs are based on a cancer risk of $1X10^{6}$ for a total cancer risk which does not exceed $1X10^{-5}$.

B = Basis is the most conservative of:

l = leaching from soil to groundwater;
dc = residential direct contact including ingestion, inhalation, and dermal; or
bu = adversely affects beneficial uses (foul odor or taste).

If the leaching pathway is not the most conservative basis, excavation RBSLs apply to subsurface soil.

**DEQ's RBCA policy includes a ceiling concentration of 500 mg/kg for total of the gasoline range fractions.**

**DEQ's RBCA policy includes a ceiling concentration of 5,000 mg/kg for the total of the diesel range fractions.**

# TABLE 3
# TIER 1 GROUNDWATER RBSLs AND STANDARDS

This table applies to groundwater and consists of WQB-7 Human Health Standards (HHSs), where available. For compounds without WQB-7 HHSs, DEQ has developed RBSLs and included them in the table. Surface water impacts require a minimum of a Tier 2 evaluation.

| Chemical | Effect | Basis | Groundwater Standard or RBSL (µg/l) |
|---|---|---|---|
| **For Gasoline and Light Hydrocarbons measured using the Massachusetts Method for Volatile Petroleum Hydrocarbons (VPH)** | | | |
| C5-C8 Aliphatics | n | rb | 400 |
| C9-C12 Aliphatics | n | rb | 400 |
| C9-C10 Aromatics | n | rb | 50 |
| MTBE | n | hhs | 30 |
| Benzene | c | hhs | 5 |
| Toluene | n | hhs | 1,000 |
| Ethylbenzene | n | hhs | 700 |
| Xylenes | n | hhs | 10,000 |
| Naphthalene | n | hhs | 100 |
| **For Diesel and Heavy Hydrocarbons measured using the Massachusetts Method for Extractable Petroleum Hydrocarbons (EPH)** | | | |
| C9-C18 Aliphatics | n | rb | 400 |
| C19-C36 Aliphatics | n | bu | 1,000 |
| C11-C22 Aromatics | n | pql | 300 |
| Acenaphthene | n | hhs | 420 |
| Anthracene | n | hhs | 2,100 |
| Benz(a)anthracene | c | hhs | 0.48* |
| Benzo(a)pyrene | c | hhs | 0.048* |
| Benzo(b)fluoranthene | c | hhs | 0.48* |
| Benzo(k)fluoranthene | c | hhs | 4.79 |
| Chrysene | c | hhs | 48 |
| Dibenzo(a,h)anthracene | c | hhs | 0.048* |
| Fluoranthene | n | hhs | 280 |
| Fluorene | n | hhs | 280 |
| Indeno(1,2,3-cd)pyrene | c | hhs | 0.044* |
| Naphthalene | n | hhs | 100 |
| Pyrene | n | hhs | 960 |

Notes:

Effect is either: n = non-carcinogenic and direct contact RBSLs are based on a hazard quotient of 1, or
c = carcinogenic and direct contact RBSLs are based on a cancer risk $1X10^{-5}$.

Basis is: rb = risk-based screening level;
hhs = WQB-7 Human Health Standard; or
pql = the risk-based RBSL of 50 µg/L is lower than the reasonably achievable practical quantitation limit of 300 µg/L
bu = adversely affects beneficial uses (foul taste or odor).
* = The best achievable practical quantitation limit (10 µg/L) may be greater than the RBSL; therefore, if the compound is detected, additional evaluation may be necessary.

**DEQ's RBCA policy includes a ceiling concentration of 1,000 µg/l total petroleum hydrocarbons.**

# Appendix F
# Data Quality Objectives Table
# Decision Error Tables

Data Quality Objectives Table

| Step 1<br>State the Problem | Step 2<br>Identify the Decision | Step 3<br>Decision Inputs | Step 4<br>Define Study Boundaries | Step 5<br>Decision Rules | Step 6<br>Tolerance Limits on Decision Errors | Step 7<br>Optimization of Sample Design |
|---|---|---|---|---|---|---|
| The former Berg Lumber Co. property has soil contaminated with petroleum hydrocarbons at levels that exceed DEQ RBSLs and PCP that exceeds EPA Region 9 PRGs and SSLs. Dioxins/furans are also present onsite. Whether contamination (PCP and dioxin in particular) has moved off site also needs to be addressed.<br><br>The results of this SAP will be used to construct a cleanup plan for the site.<br><br>Brownfield team members include Laura Alvey (DEQ, Groundwater Remediation Program), Stephanie Wallace (EPA), Curt Coover (CDM), Gwen Pozega (CDM). | Principal questions:<br><br>1. How extensive is petroleum hydrocarbon contamination above RBSLs?<br>2. How extensive is PCP and dioxins/furans contamination above action levels?<br>3. Have PCP and/or dioxins/furans migrated offsite?<br>4. Is Mn above WQB-7 standards in groundwater from natural occurrence? | Information needed:<br><br>1. Soil samples from test pits of stained areas. Analyze for PCP, Dioxin/Furans, VPH and EPH screen, and analyze fractions and PAHs if TEH exceeds 50 ppm. Compare results to DEQ RBSLs.<br>2. Soil sample from surface and subsurface will provide information regarding the extent and magnitude of PCP and dioxins/furans. Compare PCP results to EPH Region 9 PRG and SSL (DAF 10). Compare dioxins/furans TEQ to EPA Region 9 PRG.<br>3. A slug test will be performed to determine the hydraulic conductivity at the site to be used in a fate and transport model. An offsite soil sample will be collected<br>4. Install a monitoring well near southeast corner of property to determine whether elevated manganese concentrations in the groundwater are a result of on-site activities or represent background concentrations. | The study area encompasses the soil at the former BLMS site itself, the residential areas immediately across the street from the site, the ponded areas on the site, Big Spring Creek adjacent to and immediately downstream of the BLM property, and the groundwater underneath the site.<br><br>SAP field work will take place in the spring of 2007. The ground needs to be dry in order to visually find areas of soil staining.<br><br>Based on the results of the study, cleanup methods will be planned.<br><br>Regulatory comparison numbers (Action Levels) have been chosen that are protective of residential human health and migration to groundwater. | All Action Levels have been predetermined (see tables in SAP), and include DEQ RBSLs, EPA Region 9 Residential PRGs and SSLs (DAF 10).<br><br>For each analyte in each matrix, the total value of each analyte in each sample will be compared to the appropriate Action Level.<br><br>IF an analyte in a given sample exceeds the Action Level THEN additional work (cleanup, risk assessment, sampling, etc.) will need to be done.<br><br>IF an analyte in a given sample does not exceed the Action Level THEN do nothing (human health and the environment are not likely to be impacted by that analyte from that location).<br><br>The cleanup mechanisms for the site have not been established at this time. | DEQ cannot calculate Tolerance Limits on Decision Errors (TLDEs) when no data is available for a given contaminant in a specific area.<br><br>DEQ is considering stained and unstained soil as distinct "areas" within the site. Previous data is available for stained soil, and TLDEs have been calculated for the primary contaminants of concern (see Tables F1 – F4).<br><br>This investigation is focused on soil that is not stained, and it is unclear if enough data for PCP and dioxin/furan exist to develop a statistical sampling plan for the site. Due to the limited budget and to meet the goals of the investigation, samples are being collected form the area of concern rather than in a random statistical design across the site.<br><br>DEQ will assume that the laboratory analytical data represent the "true" value of the analyte in the media, assuming that appropriate QA/QC is maintained throughout the entire data acquisition process. | DEQ has constructed the SAP based on the information needed for the Decision Inputs, and also based on the budget available for the project. |

Table F1
Decision error limits table for Pentachlorophenol (PCP). The "Action Level" for PCP is 0.01 ppm, which is the USEPA Region 9 Soil Screening Level with a DAF of 10.

| True Concentration (ppm) | Correct Decision | Acceptable Probability of Making an Incorrect Decision Error (a decision error) |
|---|---|---|
| 0 – 0.005 | Does not exceed action level | 10% |
| 0.005 – 0.0075 | " | 20% |
| 0.0075 – 0.01 | " | Gray region – no probability specified |
| 0.01 – 0.015 | Exceeds action level | 5% |
| 0.015 – 7,000 | " | 1% |

Table F2
Decision error limits table for C9-C18 Aliphatics. The "Action Level" for this range of petroleum hydrocarbons is 100 ppm, which is the Montana DEQ RBCA RBSL for residential surface soil.

| True Concentration (ppm) | Correct Decision | Acceptable Probability of Making an Incorrect Decision Error (a decision error) |
|---|---|---|
| 0 – 50 | Does not exceed action level | 10% |
| 50 – 75 | " | 20% |
| 75 – 100 | " | Gray region – no probability specified |
| 100 – 150 | Exceeds action level | 5% |
| 150 – 3,610 | " | 1% |

Table F3
Decision error limits table for C19-C36 Aliphatics. The "Action Level" for this range of petroleum hydrocarbons is 2,500 ppm, which is the Montana DEQ RBCA RBSL for residential surface soil.

| **True Concentration (ppm)** | **Correct Decision** | **Acceptable Probability of Making an Incorrect Decision Error (a decision error)** |
|---|---|---|
| 0 – 1,500 | Does not exceed action level | 10% |
| 1,500 – 2,000 | " | 20% |
| 2,000 – 2,500 | " | Gray region – no probability specified |
| 2,500 – 3,000 | Exceeds action level | 5% |
| 3,000 – 56,000 | " | 1% |

Table F4
Decision error limits table for C11 – C22 Aromatics. The "Action Level" for this range of petroleum hydrocarbons is 70 ppm, which is the Montana DEQ RBCA RBSL for residential surface soil.

| **True Concentration (ppm)** | **Correct Decision** | **Acceptable Probability of Making an Incorrect Decision Error (a decision error)** |
|---|---|---|
| 0 – 25 | Does not exceed action level | 10% |
| 25 - 50 | " | 20% |
| 50 - 70 | " | Gray region – no probability specified |
| 70 - 100 | Exceeds action level | 5% |
| 100 – 7,110 | " | 1% |